# SUPPLEMENTAL MATERIALS

**Manuscript title:** Vessel wall MRI characteristics associated with intraprocedural stent thrombosis during angioplasty for intracranial atherosclerotic stenosis



Ma X, *et al. J NeuroIntervent Surg* 2023;0:1–6. doi: 10.1136/jnis-2023-020941

## 2. Supplemental Materials and Methods

### 2.2. High-resolution magnetic resonance vessel wall image acquisition

All patients were scanned on a 3.0T MRI scanner (Philips Medical Systems, Best, The Netherlands) with standard 8-channel phased array head coils. The standardized imaging protocols included diffusion weighted imaging (DWI), three-dimensional (3D) time-of-flight magnetic resonance angiography (TOF-MRA), and HR-VWI sequences. TOF-MRA and DWI were acquired in a transverse plane by using the following parameters: TOF MRA-repetition time /echo time (TR/TE), 27/6.9 ms; flip angle, 20°; field of view (FOV), 240×160 mm; matrix size = 320 × 256; layer thickness = 1.6 mm. DWI- TR-TE = 2191/95 ms, layer thickness = 6.5 mm, matrix = 200 mm × 204 mm. The maximum density projection of the TOF-MRA was used as the localization image of the HR-VWI sequences.

The HR-VWI sequences were then performed by using a volumetric isotropic turbo spin-echo acquisition (VISTA; Philips Healthcare, Best, The Netherlands) in a coronal plane (40-mm-thick slab) optimized for flow suppression and intracranial vessel wall delineation. The following parameters were used: TR/T3=800/18 ms; turbo spin-echo factor, 16 echoes; echo spacing, 6.1 ms; sensitivity encoding factor, two; number of signals acquired, 1-2; FOV, 200×180×40 mm; matrix, 332×302; acquired resolution, 0.6*0.6*0.6 mm (By interpolation, the acquired voxel is reconstructed into a size of 0.3*0.3*0.3 mm); acquisition time, 378s. A variable flip angle refocusing scheme was used with a minimum flip angle of 50° and a maximum flip angle of 120°, enabling high signal-to-noise efficiency and strong black blood effects. Radial k-space view ordering was used to optimize T1-weighted contrast.

Gadopentetate dimeglumine (Magnevist; Schering, Berlin, Germany) was administered intravenously (0.1 mmol per kilogram of body weight), and post-contrast 3D T1 imaging was repeated 5 minutes after contrast material administration. Scan parameters and sites were consistent with pre-contrast 3D T1 scan.

### 2.3. Image processing and analysis

Manual segmentation of the lumen and outer wall boundaries of culprit plaque on MR

image was performed using MR Workspace (Philips Healthcare, Best, The Netherlands). Two experienced neurologists who were blinded to patient identifiers and clinical data measured image features twice independently.

Atherosclerotic plaque on MR images was defined as eccentric wall thickening with or without luminal stenosis identified on both the reconstructed pre- and post-contrast 3D T1 images. The two neurologists qualitatively graded plaque contrast enhancement based on its signal intensity on post-contrast 3D T1 images by using the corresponding pre-contrast series. The culprit plaque was identified by another two experienced neurologists based on clinical judgment. The plaque was considered a culprit plaque when it was 1) the only lesion in the vicinity of the stroke vessel or 2) the narrowest lesion in the presence of multiple plaques in the same vessel region when stroke occurred.

**2.4. Perioperative management and stenting procedures**

We performed DSA for the responsible artery using a guiding catheter and determined the degree of stenosis according to the Warfarin-Aspirin Symptomatic Intracranial Disease (WASID) criteria. All patients were administered dual antiplatelet therapy (100 mg aspirin and 75 mg clopidogrel or cilostazol 200mg daily for at least 5 days before stenting) and received the interventional procedure under general anesthesia. In this study, all patients were used the same surgical approach and medical consumables. Pre-dilation was achieved using the Gateway balloon (Gateway-Wingspan system, Stryker, USA) with a balloon size of 80% of the normal segment diameter of the narrow distal. The Wingspan stent (Gateway-Wingspan system, Stryker, USA) was selected according to the diameter and length of the stenosis (stent extending at least 3 mm on either side of the lesion). In this study, intraoperative angiography was performed at intervals of approximately 5 minutes and at least 30 minutes after stenting for detection of IPST. IPST was recorded when intraoperative angiography showed thrombus within or adjacent to the stent. Intra-arterial injection followed by intravenous tirofiban was used as salvage treatment for patients diagnosed with IPST.

After endovascular treatment, all patients underwent computed tomography (CT) scans within 24 hours to detect bleeding or early cerebral infarction. Generally, dual

antiplatelet therapy (aspirin and clopidogrel or cilostazol orally) and statins (atorvastatin or rosuvastatin orally) were continued for 6 months post-procedure. After 6 months, one antiplatelet agent was discontinued.

**2.5. Statistical analysis**

Clinical and imaging characteristics between patients in the IPST and non-IPST groups were compared. We presented mean ± standard deviation (SD) or median ± interquartile range (IQR) for continuous variables and frequency (%) for categorical variables. The plaque characteristics between the IPST and non-IPST groups were compared using t-test for continuous variables with normal distribution, the Mann-Whitney U test for continuous variable with non-normal distribution, and the $\chi 2$ test or Fisher's exact test for categorical variables. Patients with IPST (all male) and those without IPST were matched using a 1:2 matching algorithm with age and sex as covariates. Univariate logistic regression analysis was performed for screening clinical and imaging factors associated with IPST at $P < 0.05$, and then all variables with $P < 0.05$ in the univariate analysis were considered candidates for stepwise logistic regression analysis, where the entry-level probability was set at 0.05, and the removal level was set at 0.10. Two-tailed P value < 0.05 was considered statistically significant. Multivariable binary logistic regression analysis was used to detect clinical and imaging factors associated with IPST.

**Table S1.** Characteristics of study population

| **Characteristics** | IPST group (n = 8) | Non-IPST group (n = 16) | *P* value |
|---|---|---|---|
| Age (years), mean (SD) | 58.7 (2.47) | 58.7 (1.69) | 0.999 |
| Male, n (%) | 8 (100) | 16 (100) | – |
| Hypertension, n (%) | 6 (75.00) | 10 (62.50) | 0.549 |
| DM, n (%) | 2 (25.00) | 3 (18.75) | 0.728 |
| Dyslipidemia, n (%) | 3 (37.50) | 7 (43.75) | 0.770 |
| LDL, mean (SD) | 2.19 (0.60) | 1.89 (0.55) | 0.235 |
| HDL, mean (SD) | 1.08 (0.19) | 1.00 (0.15) | 0.303 |
| TG, mean (SD) | 3.67 (0.78) | 3.33 (0.71) | 0.299 |
| TC, mean (SD) | 1.60 (0.60) | 1.57 (0.54) | 0.910 |
| Ischemic stroke history, n (%) | 4 (50.00) | 6 (37.50) | 0.558 |
| NIHSS, mean (SD) | 0.75 (1.39) | 2.00 (2.22) | 0.162 |
| Medication, n (%) | | | |
| Aspirin | 8 (100.00) | 16 (100.00) | – |
| Clopidogrel | 8 (100.00) | 16 (100.00) | – |
| Aspirin resistance and/or Clopidogrel resistance, n (%) | 0 (0.00) | 0 (0.00) | – |
| Smoker, n (%) | 4 (50.00) | 12 (75.00) | 0.231 |
| Alcohol abuse, n (%) | 7 (62.50) | 13 (81.25) | 0.328 |
| Stent location-anterior, n (%) | 3 (37.50) | 7 (43.75) | 0.770 |
| Diameter stenosis degree | 77.7(4.3) | 75.5(5.5) | 0.341 |
| Time interval between HR-VWI and intracranial stenting, mean (SD) | 2.9 (1.5) | 2.8 (1.6) | 0.542 |

IPST, intraprocedural stent thrombosis; DM, diabetes mellitus; LDL, low-density lipoprotein; HDL, high-density lipoprotein; TG, triglyceride; TC, triglyceride; NIHSS, National Institutes of Health Stroke Scale.

Continuous variables were represented as median (interquartile range) and mean (standard deviation). Categorical variables were represented as frequency and percentage.