Original Article

Correlation of fluid-attenuated inversion recovery sequence vascular hyperintensity in magnetic resonance with collateral circulation and short-term clinical prognosis in acute ischemic stroke

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Background: Accurately assessing the prognosis of patient with large-scale cerebral infarction caused by acute middle cerebral artery (MCA) occlusion in the early stages of onset can help clinicians to actively and effectively intervene, thus reducing mortality and disability rates. This study set out to investigate the predictive value of fluid-attenuated inversion recovery vascular hyperintensity (FVH) on collateral circulation and clinical prognosis.

Methods: The clinical data of 70 patients admitted to The First People's Hospital of Lianyungang from January 2018 to December 2021 with acute cerebral infarction due to occlusion of the proximal end of the M1 segment in the MCA were retrospectively collected. All patients had their first onset of disease and did not receive thrombolytic therapy at the time of onset. Subsequently, they underwent endovascular thrombectomy for treatment. The FVH and collateral vessel scores were derived according to patients' fluid-attenuated in version recovery (FLAIR) sequence and time-of-flight magnetic resonance angiography images. Based on the 90-day Modified Rankin Scale (mRS), patients were allocated to a good prognosis group (mRS ≤2) and a poor prognosis group (mRS =3–6). The correlation between the FVH and collateral vessel scores was assessed using the Spearman rank correlation test. Pearson correlation coefficient analysis was used to assess the correlation between FVH and the 90-day mRS together with the infarct size. Univariate analysis, multivariate binary logistic regression analysis, and receiver operating characteristic (ROC) curve analysis were adopted to identify those factors potentially. associated with the prognosis of patients with acute ischemic stroke (AIS).

Results: Out of 70 patients with acute unilateral MCA occlusion (MCAO) who met the inclusion criteria, 62 showed positive FVH sign. These 62 patients were divided into a good prognosis group (n=32) and a poor prognosis group (n=30) based on the mRS score 90 days after discharge. The Spearman rank correlation test indicated that FVH was positively correlated with collateral vessel grade (Spearman rho =0.865; P<0.001); meanwhile, Pearson correlation coefficient analysis indicated that FVH score had moderate negative correlation with 90-day mRS score (r=−0.605; P<0.001). The results of multivariate binary logistic regression analysis indicated that collateral vessel grade and FVH score may be associated with the prognosis of patients with AIS, and the area under the curve (AUC) of FVH score was larger than collateral vessel grade (AUC =0.738).

Conclusions: There was a positive correlation between FVH score and collateral vessel grade, and FVH score could indicate collateral circulation. FVH score was negatively correlated with 90-day mRS score and infarct volume and thus can predict clinical prognosis.

Keywords: Acute ischemic stroke (AIS); vascular hyperintensity; collateral circulation; prognosis

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Introduction

Large-area cerebral infarction caused by intracranial large vessel stenosis and occlusion is a disease that seriously affects the health and quality of life of patients while imposing a considerable burden on individuals, families, and society. Atherosclerotic plaque is a key factor that causes cerebral large vessel occlusion, of which the most common involved vessel is the middle cerebral artery (MCA) (1). With the continuous maturity of imaging technology and intravascular intervention technology, the effectiveness and safety of intravascular mechanical thrombectomy for acute large vessel occlusive ischemic stroke have been widely accepted, particularly given the low rate of vascular recanalization and high risk of intracranial hemorrhage transformation and reocclusion in intravenous thrombolysis for large-vessel occlusive cerebral infarction. The prevalent effective treatment method for patients with acute MCA occlusion (MCAO) is ultra-early intravascular intervention, which can achieve reperfusion of occluded blood vessels (2). The early assessment of the prognosis of acute massive cerebral infarction and targeted active clinical interventions can help reduce mortality and disability rates. In recent years, it has been suggested that the fluid-attenuated inversion recovery vascular hyperintensity (FVH) in magnetic resonance imaging (MRI) may be used to visualize the leptomeningeal collateral vascular anastomosing branches. Sanossian *et al.* compared the gold-standard fluid-attenuated in version recovery (FLAIR) sequence with digital subtraction angiography (DSA) by establishing a comparison group and concluded that FVH is a collateral circulation of the pia mater formed by slow peripheral blood flow compensation after severe stenosis or occlusion of the responsible major artery (3). Legrand *et al.* used DSA to measure the degree of MCA stenosis and further clarified the relationship between FVH and vascular stenosis. The results showed that the main pathological and physiological basis of FVH is the formation of the pia mater collateral circulation after severe stenosis or occlusion of intracranial large vessels (4). Thus far, few studies have examined the relationship between FVH and collateral circulation and its correlation with clinical prognosis, Wei *et al.* investigated the value of sensitivity-weighted imaging asymmetric prominent venous sign (APVS) and magnetic resonance FVH in predicting collateral circulation and prognosis in patients with acute anterior circulation ischemic stroke. They provided a comprehensive evaluation of collateral circulation with reference to the veins and arteries and concluded that FVH is an independent risk factor for poor prognosis (5). There is considerable controversy regarding whether the collateral circulation reflected by FVH can play an effective compensatory role. Nave *et al.* used the FVH-Alberta Stroke Program Early Computed Tomography CT Score (ASPECTS) to evaluate patients with AIS and untreated MCA-M1 segment occlusion. The results showed that lower FVH scores were associated with good collateral and functional prognosis, suggesting that FVH is a predictive factor for poor prognosis (6). Flacke *et al.* noted that patients with FVH sign showed poor clinical prognosis on MRI within 2 hours, with persistent vascular occlusion being identified as possible cause (7). In Jing *et al.*'s study, FVH

Table 1 The scanning parameters for each sequence

Sequence	Rotating angle (degree)	TR (ms)	TE (ms)	Layer thickness (mm)	Layer spacing (mm)	Scanning duration (s)
T1W	120	2,200	24	5	1.2	80
T2W	90	4,518	80	5	1.2	45
DWI	90	2,400	76	5	1.2	96
FLAIR	120	9,000	140	5	1.2	45
3D-TOF MRA	20	26	3.5	1.2	0.6	160

TR, time to repetition; TE, time to echo; T1W, T1-weighted; T2W, T2-weighted; DWI, diffusion-weighted imaging; FLAIR, fluid-attenuated in version recovery sequence; 3D-TOF, three-dimensional time of flight; MRA, magnetic resonance angiography.

score was not able to predict the 90-day clinical prognosis of patients with AIS because although the distal FVH could reflect collateral circulation, it did not play a compensatory role (8). Mahdjoub *et al.* reported that a higher FVH score was associated with good collateral and a better 90-day clinical prognosis (9).

In the present study, we aimed to ascertain the correlation between the FVH and collateral vessel scores, infarct volume at presentation, and the 90-day mRS and clarify the relationship between FVH and the clinical prognosis. We present this article in accordance with the STROBE reporting checklist (available at https://qims.amegroups.com/article/view/10.21037/qims-23-1640/rc).

Methods

General information

This study was conducted in accordance with the Declaration of Helsinki (as revised in 2013) and was approved by the Ethics Committee of the First People's Hospital of Lianyungang (No. LW-20220103001). Informed consent was obtained from all the patients. Data from 70 patients with acute ischemic stroke (AIS) caused by occlusion of the MCA who received treatment at The First People's Hospital of Lianyungang from January 2018 to December 2021 were collected. These patients did not receive drug thrombolysis treatment until imaging examination, and subsequently underwent intravascular mechanical thrombectomy. The inclusion criteria were as follows: (I) first onset, (II) time between onset and MRI examination <12 h, (III) imaging examination confirming occlusion of the proximal end of unilateral M1 MCA segment and acute infarction of the blood supply, (IV) no medication for thrombolysis treatment given at the first onset of the disease, and (V) treatment with intravascular mechanical thrombectomy.

The time from symptom onset to completion of MRI and admission to hospital varied from 2 hours to 12 hours among all patients, but was primarily within 6 hours.

The exclusion criteria were as follows: (I) a previous history of stroke, (II) bilateral cerebral involvement, (III) multiple lacunar cerebral infarction and old softening lesions, (IV) recurrence of acute onset after drug thrombolysis or surgical thrombectomy treatment, (V) a lack of diagnosis due to poor image quality, and (VI) presence of brain parenchymal lesions, such as brain tumors and cerebral aneurysms.

General patient information was collected, including gender, age, and the risk factors for cerebrovascular disease (hypertension, diabetes mellitus, hyperlipidemia, atrial fibrillation, etc.). Patients were evaluated using the National Institutes of Health Stroke Scale (NIHSS) upon admission and discharge. The mRS score was used for the 90-day evaluation. Those with mRS ≤2 were considered to have a good prognosis, while those with mRS =3–6 were considered to have a poor prognosis.

Examination methods

A Signa HDx 3.0T MR device (GE HealthCare, Chicago, IL, USA) with an 8-channel head coil was used to examine all patients. The scanning sequences included T1-weighted imaging, T2-weighted imaging, FLAIR, diffusion-weighted imaging (DWI), and three-dimensional (3D) time-of-flight (TOF) MR angiography (MRA). The scanning parameters are listed in *Table 1*.

Image analysis

Analysis of MCAO

The MCA can be divided into four segments based on its course: M1 horizontal segment, M2 insular segment, M3 fissure segment, and M4 cortical segment. Select patients with M1 segment occlusion of the MCA based on TOF-MRA, original images and MRA imaging.

FVH scoring

All MR images were imported into an MR Advantage Workstation 4.5 (GE HealthCare) for postprocessing. A modified ASPECTS method was adopted for the FVH scoring (10). The MCA blood supply area was divided into seven regions: the anterior MCA cortical region, the anterior superior MCA cortical region, the posterior superior MCA cortical region, the posterior superior cortical region, the insular region, the lateral insular cortical region, and the lateral superior insular cortical region. The presence of positive FVH in each region was scored as 1 point, while the absence of FVH in all regions was scored as 0. The maximum score was 7 points.

Collateral circulation scoring

TOF-MRA can accurately display the vascular structure, which contains information about the fluid reaching a certain flow rate in the lumen, which in turn can reflect collateral circulation function. The maximum density projection method has higher specificity than does the original image. In TOF-MRA images, the affected MCA blood supply area was compared with the contralateral normal cerebral hemisphere. A four-point evaluation method was applied according to the percentage of display of a collateral vessel as follows (11): no collateral vessel = 1 point, collateral vessel <50% = 2 points, 50%< collateral vessel <75% = 3 points, and collateral vessel ≥75% = 4 points. A score of 3–4 points was considered good collateral circulation, while a score of 1–2 points was considered poor collateral circulation.

Infarct size calculation in AIS

The AIS was manually outlined on DWI with b=1,000 s/mm^2 by selecting the area with DWI hyperintensity and hypointensity on the apparent diffusion coefficient image. The area and the cerebral infarct size of the outlined section at this layer was calculated by the open-source software ITK-SNAP (version:3.4.0; http://www.itksnap.org). The FVH and collateral vessel scores were evaluated separately by two associate chief imaging physicians, and cerebral infarct volumes were outlined, calculated, and averaged by two physicians, respectively. The assessment of MRI parameters was performed in a blinded fashion.

Statistical analysis

SPSS v. 19.0 software (IBM Corp., Armonk, NY, USA) was used for the data analysis. The measurement data that satisfied the normal distribution are expressed as the mean ± standard deviation ($\bar{x}$ ± s). The countable data are expressed as percentages. For intergroup comparisons, a *t*-test was used for continuous variables, and the chi-square test was used for categorical variables. The variables with P<0.1 in the intergroup analysis of differences of univariate variables were introduced into the logistic regression analysis model to clarify the relationship between each factor and the clinical prognosis in all cases with AIS, the good prognosis group, and the poor prognosis group, respectively. A value of P<0.05 was considered statistically significant. The P values for statistical tests were two-sided. Spearman rank correlation analysis was used to assess the correlation between the FVH and collateral vessel scores, and Pearson correlation coefficient was used to assess the correlations between FVH and both the 90-day mRS and the infarct size. The kappa coefficient was used to evaluate the consistency between the two physicians for the FVH score, the NIHSS score at admission, the NIHSS score at discharge, the infarct size, and the 90-day mRS. The κ value could be between 0 and 1, with κ>0.6 indicating good consistency and κ>0.8 indicating very good consistency.

Results

This study selected a total of 194 patients with acute MCAO. A total of 124 patients were excluded for the following reasons: Non-first-time onset patients, nonunilateral MCA, first MRI time >24 hours, pre-MRI drug thrombolysis treatment, comorbidities such as cerebral hemorrhage and brain tumors, poor image quality that affected observation, and other treatment methods for nonmechanical thrombectomy. A total of 70 patients met the inclusion criteria. Among them, there were 62 patients who showed positive FVH sign (88.57%), 32 males (51.61%), and 30 females (48.39%). The mean time from onset to MRI examination was 6.75±1.58 hours (IQR 5.70–7.56). After discharge, patients were followed up and divided into two groups based on their 90-day mRS score: a group with good prognosis and a group with poor prognosis (*Figure 1*).

The kappa test results showed very good consistency between the two physicians for the FVH score (κ=0.91).

According to the 90-day mRS, the patients were divided into the good prognosis (mRS ≤2) group (32 cases: 17 males

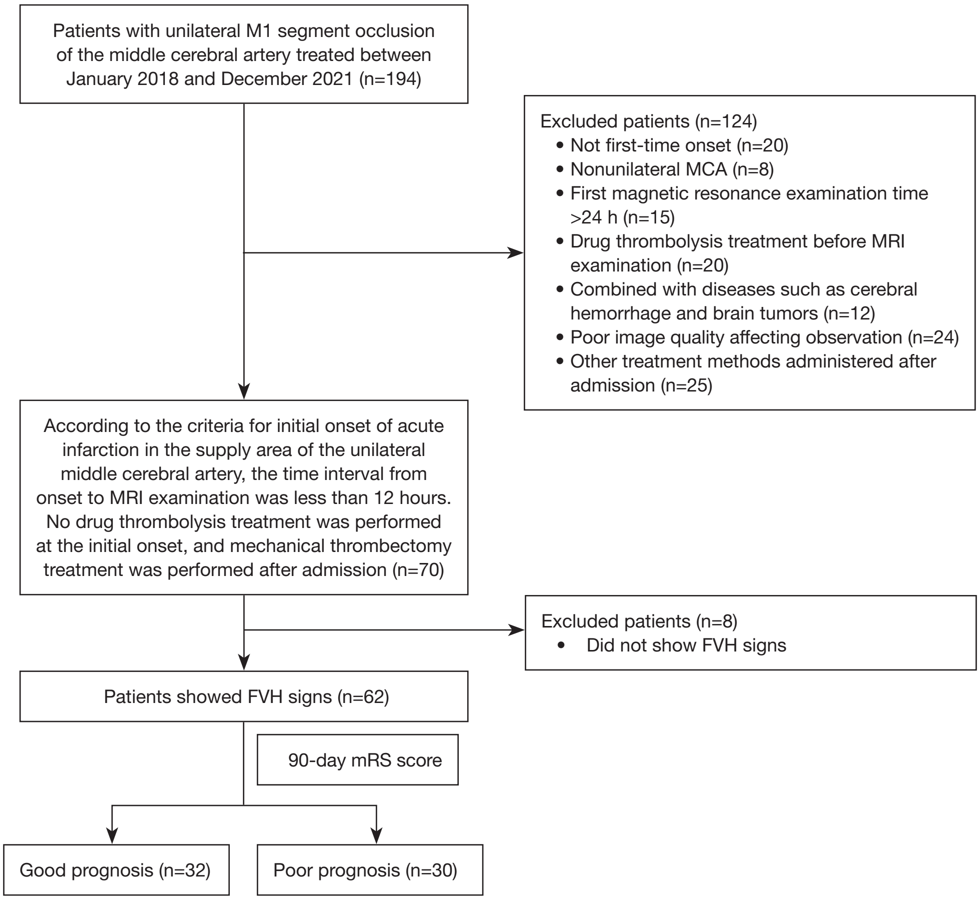

Figure 1 The flowchart of participant inclusion. MRI, magnetic resonance imaging; MCA, middle cerebral artery; FVH, fluid-attenuated inversion recovery vascular hyperintensity; mRS, Modified Rankin Scale.

Table 2 The results of univariate analysis of the relevant parameters in the patients

Characteristics	Good prognosis group (n=32)	Poor prognosis group (n=30)	P
Age (years)	68.72±4.94	70.53±5.07	0.157
Gender (male/female)	17/15	15/15	0.809
Hypertension	19/59.38%	23/76.67%	0.150
Hyperlipidemia	22/68.75%	20/66.67%	0.864
Diabetes mellitus	11/34.38%	11/36.67%	0.853
Atrial fibrillation	9/28.13%	10/33.33%	0.663
NIHSS score at admission	13.91±3.52	15.57±5.31	0.150
NIHSS score at discharge	5.69±2.38	7.03±3.22	0.065*
Infarct volumes (mm3)	18.75±7.00	23.93±11.53	0.035*
Collateral circulation score	2.81±0.69	2.43±0.82	0.053*
FVH score	4.69±0.90	3.60±1.30	<0.001*

*, P<0.1. Continuous variables are presented as the mean ± standard deviation, and the binary variables are presented as the frequency and proportion (%). NIHSS, National Institutes of Health Stroke Scale; FVH, fluid-attenuated inversion recovery vascular hyperintensity.

Table 3 The multivariable logistic regression analysis of clinical prognosis in patients with acute stroke

Parameter	OR	95% CI	P
The NIHSS score at discharge	0.967	0.689–1.357	0.845
Infarct size	0.848	0.714–1.007	0.848
FVH score	0.034	0.004–0.270	0.001*
Collateral vessel grade	8.467	1.203–59.611	0.032*

*, P<0.05. OR, odds ratio; CI, confidence interval; NIHSS, National Institutes of Health Stroke Scale; FVH, fluid-attenuated inversion recovery vascular hyperintensity.

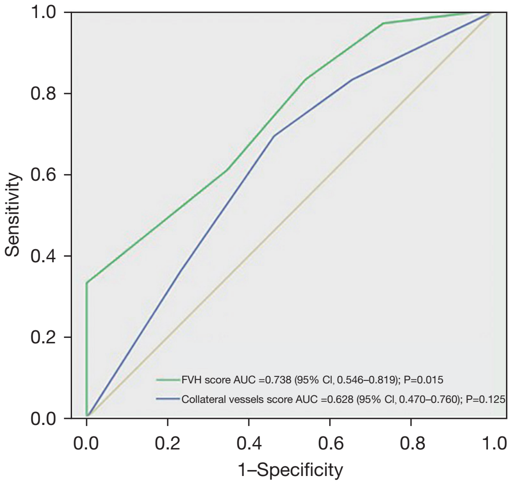

Figure 2 ROC curve for determining the prognosis according to the relevant parameters. The AUCs of the collateral vessel grade and FVH score were 0.628 (95% CI: 0.470–0.760; P=0.125) and 0.738 (95% CI: 0.546–0.819; P=0.015), respectively. ROC, receiver operating characteristic; FVH, fluid-attenuated inversion recovery vascular hyperintensity; AUC, area under the curve; CI, confidence interval.

and 15 females) or the poor prognosis (mRS 3–6) group (30 cases: 15 males and 15 females). The correlation between each clinical indicator and the prognosis was analyzed, with the results being listed in *Table 2*.

The results of the univariable analysis showed that the differences in age, the NIHSS score at admission, hyperlipidemia, hypertension, diabetes mellitus, and atrial fibrillation were not statistically significant between the two groups (all P values >0.1). The differences in discharge NIHSS score, infarct volume, collateral grading, and FVH score had a P value of <0.1. Although hypertension is a critical factor in the onset of cerebral infarction, it is not clear whether it leads to stroke in the acute stage of treatment. Therefore, hypertension was also included in the logistic regression analysis model. The results showed that the differences in hypertension [odds ratio (OR) 0.783; 95% confidence interval (CI): 0.057–1.224; P=0.089], discharge NIHSS score (OR 0.967; 95% CI: 0.689–1.357; P=0.845), infarct volume (OR 0.848; 95% CI: 0.714–1.007; P=0.848) were not statistically significant (P>0.05). Collateral vessel grade (OR 8.467, 95% CI: 1.203–59.611; P=0.032) and FVH score (OR 0.034, 95% CI: 0.004–0.270, P=0.001) were statistically significant and independent predictors of clinical prognosis (*Table 3*).

The collateral vessel and FVH scores were included in the receiver operating characteristic (ROC) curve analysis, The area under the curve (AUC) of the collateral vessel grade was 0.628 (95% CI: 0.470–0.760; P=0.125), and the AUC of the FVH curve was 0.738 (95% CI: 0.546–0.819; P=0.015) (*Figure 2*).

Spearman rank correlation was used to assess the correlation between the FVH score and collateral vessel grade, with r=0.865 (P<0.001). Pearson correlation coefficient was used assess the correlation between the FVH score and both the 90-day mRS and the infarct size, with r=−0.605 (P<0.001) and r=−0.866 (P<0.001), respectively.

Discussion

Severe stenosis or occlusion of the MCA causes a decrease in blood perfusion to the cerebral tissue in its blood supply area, leading to ischemic cerebrovascular events. There are numerous causes of cardiovascular disease, for example, damage to the cerebral blood vessels, which may lead to a reduced or no blood supply to the brain. Once there is no oxygen delivery to the brain, brain damage is irreversible. It has been suggested that when a patient has a history of three or more ischemic strokes, the risk of recurrence is greatly increased (12). Collateral circulation refers to the condition in which the large intracranial arteries are severely stenosed or occluded, and in which the blood flow changes its circulation path and reaches the ischemic area through the anastomosis of new blood vessels or other normal cerebral vessels. This reverses the blood flow to the cerebral tissue in the ischemic area and causes different degrees of compensatory perfusion there (13). The degree of opening of the collateral vessels has an important effect on the prognosis of patients (14). Furthermore, good collateral access exerts a substantial protective effect on the ischemic

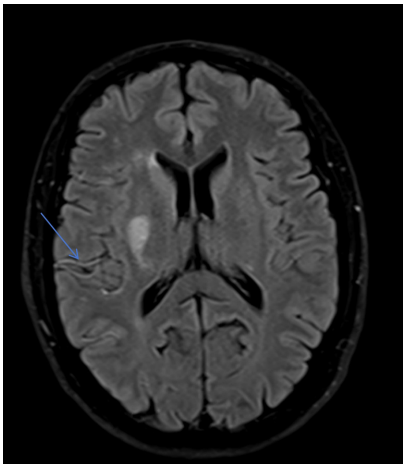

Figure 3 Positive fluid-attenuated inversion recovery vascular hyperintensity sign, presence of right basal ganglia acute ischemic stroke, and T2 fluid-attenuated in version recovery sequence showing multiple linear hyperintensities at the sulcus of the right temporal lobe (arrow).

cerebral tissue: it can improve its condition, maintain perfusion, increase the benefit rate of revascularization therapy, reduce the incidence of cerebrovascular events, reduce the number of cerebral infarcts and infarct size, facilitate the recovery of neurological function in the lesion area, and improve the clinical prognosis (15).

Most studies in this area have concluded that the degree of collateral circulation established can effectively predict the clinical outcome of patients. Digital subtraction angiography (DSA) is currently recognized as the gold standard for the assessment of collateral vascularization. However, it is a complex, invasive, highly radioactive examination with many complications and is rarely adopted in clinical practice for collateral vascular assessment.

In 1999, Cosnard *et al.* (16) first reported MRI FVH on the FLAIR sequence of cranial MRI. As shown in *Figure 3*, it appears as a linear and "snake-shaped" high signal shadow and is usually distributed along the brain surface or sulcus, with the frontal and temporal lobes being the more common sites. At present, the cause of MRI FVH has not yet been determined, but most researchers believe that it may be caused by the disappearance of the flow void effect of blood due to disordered and slow blood flow. Mori *et al.* (17) compared intraoperative observations of craniotomy and imaging results in patients with moyamoya disease with positive FVH and suggested that the significantly dilated leptomeningeal vessels on the cerebral tissue surface cause the formation of FVH.

However, there is still controversy concerning whether the collateral circulation in response to FVH can play an effective compensatory role. The results our study showed that FVH score was positively correlated with leptomeningeal collateral circulation, as shown in *Figure 4*, in which the patient had an FVH score of 5, a collateral vessel score of 4, and a 90-day mRS of 1. The patient in *Figure 5* had an FVH score of 2, a collateral vessel score of 2, and a 90-day mRS of 3. We also found positive correlation between the FVH and collateral vascular scores, indicating that positive FVH represents good collateral circulation, which is consistent with the finding of a higher FVH score in the good prognosis group, indicating the same. This is also in line with results reported by Jing *et al.* (18) but different from those reported by Chen *et al.* (19).

Furthermore, 88.57% (62/70) of the cases in our study showed positive FVH sign. In Sanossian *et al.*' study (3), the incidence of FVH positivity was 49%, while in Kamran *et al.*'s study (20), the incidence of FVH positivity in patients with large artery occlusion was 97%. The discrepancy in the above results might be related to the different intervals between the onset of the disease and completion of the imaging in patients. Maeda *et al.* (21) found a negative correlation between the occurrence of the FVH signs and time, with a prolongation in onset time being correlated with a decrease in the incidence of FVH. This relationship should be analyzed in future studies.

There are few reports on FVH in the literature, and studies on the prognostic value of FVH have not been uniformly conclusive (22). Three main views exist regarding the correlation between FVH and prognosis: (I) FVH might be associated with a poor prognosis. The results of the study by Nave *et al.* (6) showed that lower FVH scores were correlated with good collateral circulation and a good 90-day prognosis. (II) FVH might be correlated with a good prognosis. Tong *et al.* (23) reported that higher FVH scores were correlated with good collateral circulation and a good 90-day prognosis. (III) FVH does not correlate with prognosis in patients with AIS. In their study, Jing *et al.* (8) concluded that FVH was not correlated with the clinical prognosis of patients with AIS, and although the collateral circulation flow represented by FVH was slow or reversed, it did not play a compensatory role.

In our study, the multivariable binary logistic regression analysis between the good prognosis and the poor prognosis groups showed that the FVH score and the collateral vascular grading were correlated with the prognosis of

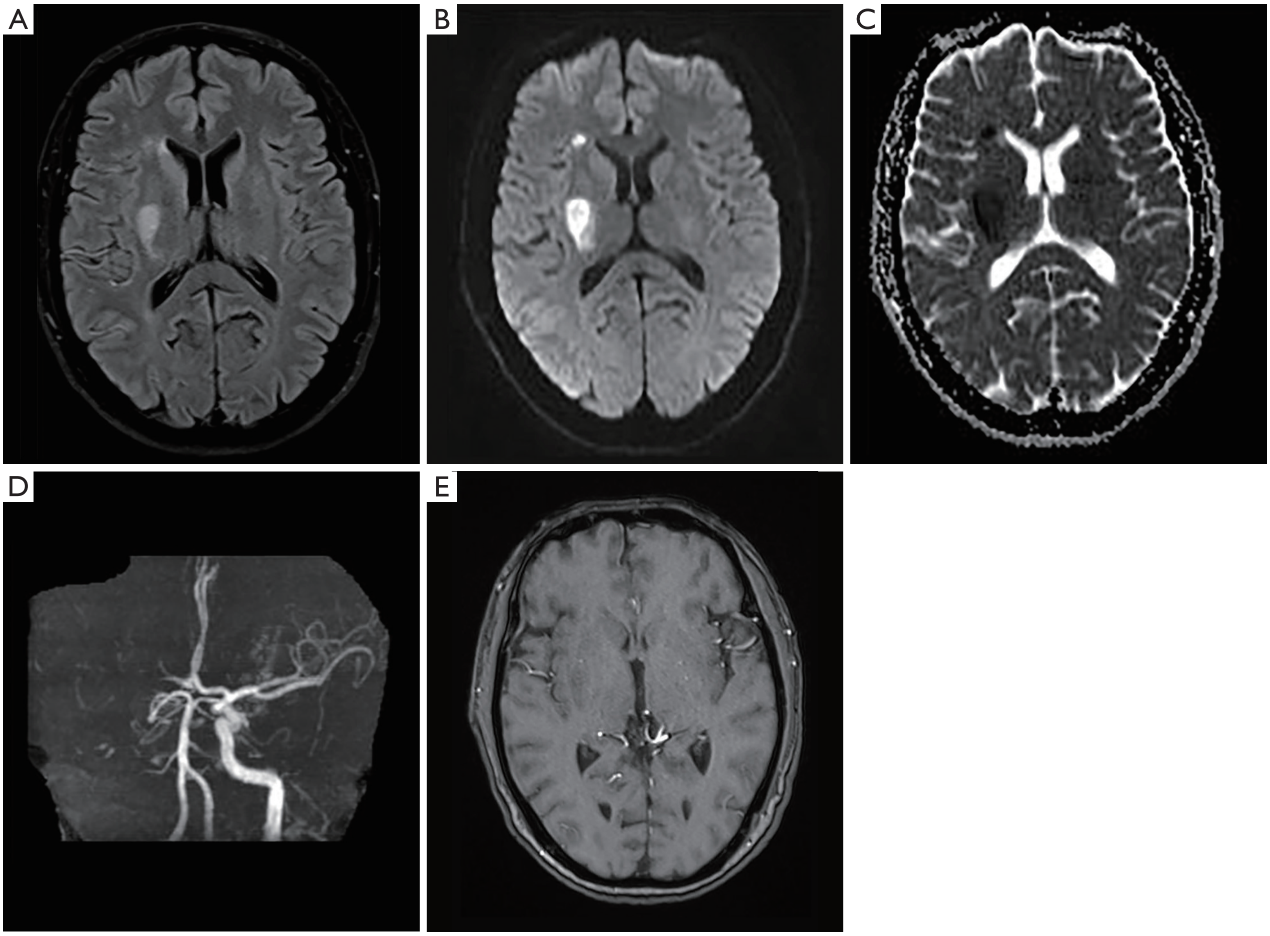

Figure 4 Case 1: a 62-year-old male with sudden limb weakness for one day. (A) A right paraventricular infarct, with a T2-FLAIR sequence showing a strip-shaped high signal in the subcortical area of the right temporal lobe, with a FLAIR vascular high signal sign with a score of 5. (B) Hyperintense DWI of the lesion. (C) A decreased ADC in the lesion. (D) Right middle cerebral artery occlusion. (E) Relatively rich right meningeal collateral vessels with a score of 4. The 90-day mRS was 1. FLAIR, fluid-attenuated in version recovery sequence; DWI, diffusion-weighted imaging; ADC, apparent diffusion coefficient; mRS, Modified Rankin Scale.

patients with AIS, with a higher FVH score and a higher collateral vascular grading being correlated with a good prognosis. Moreover, we found a negative correlation of FVH score with infarct volume and 90-day mRS. This suggests that patients with higher FVH scores have smaller infarct sizes and better clinical prognoses. This might be because FVH involves a slow and reversed leptomeningeal blood flow, and an abundance of collateral vessels might reduce the extent and degree of cerebral tissue damage, increase the compensatory blood supply and activity of cerebral tissue, better restore its function, and thereby improve the clinical prognosis.

The discrepancy between our study's results with those reported elsewhere may be explained as follows: (I) there are various methods for the assessment of collateral vessels and FVH, such as quantitative, semiquantitative, and qualitative assessments, which are not yet uniform and may influence the results. (II) Different scanning parameters and equipment models selected by the investigators might have caused discrepancies in image development and observation results. (III) The differences in the inclusion criteria, such as the time interval from the onset of disease to imaging, and the medication of diseases potentially being associated with the risk factors for cerebrovascular disease might also produce varying outcomes. In addition, different sites of the same affected vessel might produce differences in disease course and prognosis. (IV) Some reports in the literature suggest that small-vessel disease may be a variable

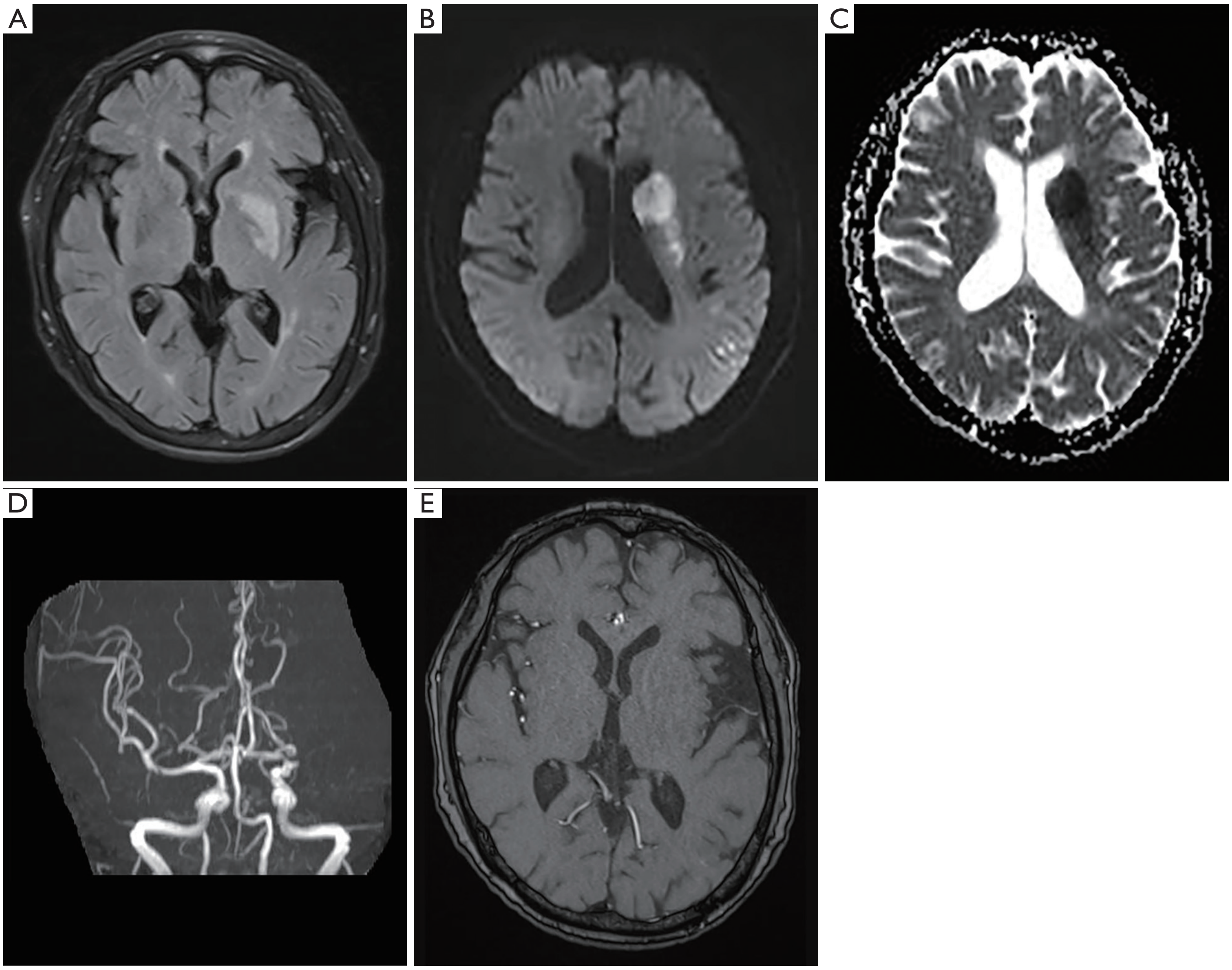

Figure 5 Case 2: a 54-year-old male with sudden dizziness and weakness for one day. (A) Infarct foci in the left basal ganglia region with a positive FVH sign with a score of 2. (B) Hyperintense DWI of the lesion. (C) A decreased ADC in the lesion. (D) Left middle cerebral artery occlusion. (E) The meningeal collateral vessels with a score of 2. The 90-day mRS was 3. FVH, fluid-attenuated inversion recovery vascular hyperintensity; DWI, diffusion-weighted imaging; ADC, apparent diffusion coefficient; mRS, Modified Rankin Scale.

that affects collateral circulation and may impact clinical prognosis (24). Unfortunately, this study selected patients with occlusion of the starting portion of the MCA, excluded patients with multiple lacunar infarction, and had a small sample size. Therefore, no comparative analysis of small vessel disease scores between the groups was conducted.

The limitations of this study are as follows: (I) a relatively small sample size was employed. (II) The score of collateral vessels and FVH in cases were based on MRI examinations and were not compared with those of DSA. (III) Only patients with infarction in the MCA supply area were enrolled, the condition of the site of the affected vessel was not taken into consideration, and the applicability of the findings to a cerebral infarction due to other large vessel lesions was not investigated. (IV) There is research indicating that small-vessel disease may be a variable that affects collateral circulation and could influence clinical prognosis. However, only two patients in our study had combined small-vessel disease, and thus no comparative analysis of small-vessel disease scores between the groups could be conducted.

Conclusions

In our study, the positivity of FVH was 88.56% in patients with acute massive cerebral infarction caused by severe stenosis or occlusion of the MCA. The FVH score was positively correlated with, and could accurately assess, leptomeningeal collateral circulation. The FVH score was negatively correlated with the 90-day mRS and infarct size, and a higher FVH score predicted a smaller infarct size and a better clinical prognosis.

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Footnote

Reporting Checklist: The authors have completed the STROBE reporting checklist. Available at https://qims.amegroups.com/article/view/10.21037/qims-23-1640/rc

Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at https://qims.amegroups.com/article/view/10.21037/qims-23-1640/coif). The authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. This study was conducted in accordance with the Declaration of Helsinki (as revised in 2013) and was approved by the Ethics Committee of The First People's Hospital of Lianyungang (No. LW-20220103001). Informed consent was obtained from all patients.

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