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ASSOCIATION OF CT ANGIOGRAPHIC COLLATERAL STATUS WITH STROKE SEVERITY AND FUNCTIONAL OUTCOMES IN PATIENTS WITH ACUTE ANTERIOR CIRCULATION ISCHEMIC STROKE: A PROSPECTIVE COHORT STUDY

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ABSTRACT

Background: Cerebral collateral circulation plays a crucial role in maintaining cerebral perfusion and limiting ischemic injury following acute arterial occlusion. Computed tomography angiography (CTA) enables noninvasive assessment of collateral circulation and may provide valuable prognostic information regarding stroke severity and functional recovery.

Objective: To evaluate the association of CTA collateral status with admission stroke severity, early neurological improvement, and 90-day functional outcomes in patients with acute anterior circulation ischemic stroke.

Methods: This Multicenter prospective cohort study included 150 patients with acute anterior circulation ischemic stroke enrolled between January 2025 and January 2026 at District Headquarters Hospital, Nankana Sahib, and Allied Hospital, Faisalabad, affiliated with Faisalabad Medical University, Pakistan. CTA collateral status was classified as good (grades 2–3) or poor (grades 0–1). Clinical assessments included the National Institutes of Health Stroke Scale (NIHSS), Alberta Stroke Program Early CT Score (ASPECTS), early neurological improvement, symptomatic intracranial hemorrhage, and 90-day modified Rankin Scale (mRS). Multivariable logistic regression was used to identify factors associated with functional independence (mRS 0–2).

Results: Of 150 patients, 86 (57.3%) exhibited good collateral circulation and 64 (42.7%) had poor collateral circulation. Patients with good collaterals demonstrated significantly lower median NIHSS scores (12 vs. 18; $P<0.001$) and higher median ASPECTS scores (8 vs. 7; $P<0.001$). Functional independence at 90 days was significantly greater in the good-collateral group (69.8% vs. 26.6%; $P<0.001$). Early neurological improvement occurred in 62.8% versus 32.8%, respectively, while 90-day mortality was lower (3.5% vs. 15.6%). After adjustment for age, NIHSS, ASPECTS, occlusion location, and endovascular thrombectomy, good collateral circulation remained significantly associated with functional independence (adjusted odds ratio: 2.79; 95% CI: 1.17–6.65; $P=0.021$).

Conclusion: Favorable CTA collateral status was independently associated with reduced stroke severity and improved neurological and functional outcomes at 90 days. CTA collateral assessment represents a valuable complementary imaging marker for prognostic evaluation in acute anterior circulation ischemic stroke.

KEYWORDS: Acute Ischemic Stroke; CT Angiography; Cerebral Collateral Circulation; NIHSS; ASPECTS; Modified Rankin Scale; Functional Outcomes.

INTRODUCTION

Occlusion of a major vessel in the anterior cerebral circulation can cause profound neurological disability, yet patients with comparable occlusion sites often follow different clinical courses. Although there are now more reperfusion therapies available, re-opening of the artery alone cannot account for the differences in extent of infarct growth or recovery afterwards. This information is supplemented by the clinical context, which is provided by the amount of tissue that is being supplied blood through alternate pathways and by the duration of symptoms and the neurological deficit at baseline. Thus, modern assessment of stroke depends on bedside assessment and parenchymal and vascular imaging and is not limited to just the location of arterial occlusion [1-3].

After occlusion of the intracranial carotid or middle cerebral artery, surrounding arterial territories can provide blood to the area in danger through leptomeningeal connections. This compensatory flow is variable among people and depends on the vascular anatomy, systemic pressure, how the blood is regulated, and the duration of ischemia. With extensive collateral recruitment, perfusion may be adequate to slow the rate of tissue damage; with less recruitment, the rate of tissue damage may speed up to become an infarction. However, the association between

collateral appearance and recovery is only observational, and the vessels alone cannot be assumed to be the cause of better recovery [2,4].

CTA is useful in giving more than just the identification of the vessel blocked, as the contrast can be seen in the vessels distal to the lesion. The semiquantitative collateral scale as proposed by Tan et al. assesses enhancement in the territory of the involved MCA compared to the other hemisphere [3]. Timing of image acquisition is crucial, as a delayed arrival of the contrast may make the collateral filling appear inadequate on a single acquisition, but multiphase imaging can provide a delayed image acquisition that can capture the later filling. Therefore, collateral scores need to be analyzed in relation to the technique used for acquiring the image, the noncontrast CT results, and the neurological presentation of the patient [3,4].

Benefit prediction when considering thrombectomy should take into account other factors beyond simply vessel accessibility. Randomized-trial evidence established endovascular treatment for selected large-vessel occlusions, while DAWN and DEFUSE 3 supported treatments of appropriately selected patients beyond the conventional early window [5–7]. Evidence of collateral flow was included in the selection process for treatment in MR CLEAN-LATE 6 to 24 hours [8]. These data emphasize the need for physiologic and imaging context: collateral visualization provides context but is not sufficient to make the decision whether or not to pursue reperfusion.

Previous observational investigations and pooled analyses have generally linked more robust collateral filling with better post-thrombectomy outcomes [9–11]. Some effect sizes have been reported, however, and this discrepancy is due in part to the use of different collateral scales, CTAs, arterial distributions, baseline infarct measurements, and reperfusion strategies. Published estimates will thus not apply to another clinical setting. Evaluating this association within local stroke services may help clarify the practical contribution of collateral grading [12–14].

A clinically useful imaging marker should have information other than what is available at presentation. The NIHSS is a measure of the neurologic deficit in the patient and the ASPECTS is a total of early ischemic change on noncontrast CT. Both are inadequate in describing the angiographic amount of alternate vascular filling. All of these measures, taken together, both by site of occlusion and by acute treatment, may give an insight into the significance of CTA collateral grading in prognosis. Reproducible image interpretation, as well as full follow-up, is all the more crucial when the goal is functional independence several months post-event [11-13]. This study evaluated the reported association between baseline CTA collateral status, acute neurological severity, and functional outcome 90 days after anterior-circulation ischemic stroke. Early NIHSS improvement, symptomatic intracranial bleeding and death were secondary outcomes. A second objective was to assess the durability of the collateral–outcome relationship after accounting for selected clinical, imaging, and treatment factors.

MATERIALS AND METHODS

Study Design and Setting

This prospective, two-center observational cohort study was conducted at District Headquarters Hospital, Nankana Sahib, and Allied Hospital, Faisalabad, affiliated with Faisalabad Medical University, Pakistan. In patients with acute anterior circulation ischemic stroke, the relationship between collateral circulation on computed tomography angiography (CTA) and neurological severity, radiological features, early clinical improvement, and functional outcomes was examined. Subjects were selected from January 2025 to January 2026, and functional outcomes were evaluated 90 days after the index stroke. The participating hospitals emergency, clinical, and radiology services were used to conduct clinical evaluations, acute stroke management, and neuroimaging assessments. The study was designed and reported based on the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines [14].

Study Population and Sampling Technique

Using consecutive nonprobability recruitment, 150 eligible adults were included from the participating emergency and acute stroke services. Exposure groups were assigned from the baseline CTA collateral grade: grades 2–3 formed the good-collateral group and grades 0–1 the poor-collateral group. These categories were compared with respect to baseline characteristics, vascular comorbidities, neurological and imaging measures, use of acute therapies, 24-hour improvement, and 90-day outcomes. The prespecified primary association of interest was between CTA collateral status and functional status at 90 days.

Inclusion and Exclusion Criteria

The inclusion criteria for enrollment were patients aged ≥18 years with clinical diagnosis of acute ischemic stroke and CTA findings of large-vessel occlusion of the anterior circulation. Eligible arterial sites comprised the intracranial internal carotid artery, the middle cerebral artery M1 segment, or a proximal M2 segment. Further requirements were good baseline noncontrast CT, CTA within 24 hours of last known-well time, documented admission NIHSS assessment, and adequate baseline clinical and radiological records.

Patients were excluded if they had primary intracerebral hemorrhage, posterior-circulation stroke, bilateral anterior-circulation large vessel occlusion with inadequate collateral comparison, or prestroke disability greater than mRS 2. Examinations where motion, inadequate contrast opacification or inadequate arterial coverage were

present were excluded, as were presentations in which the neurological deficit could not be reliably evaluated due to the clinical condition.

Clinical Assessment and Data Collection

Demographic details and clinical observations were entered on a structured study record. Vascular risk factors noted were hypertension, diabetes, dyslipidaemia, atrial fibrillation, tobacco consumption, previous ischemic stroke and other cardiovascular disease. Sex, time of symptom onset or last known to be well, imaging delay, admission blood pressure, admission blood glucose, and treatment during acute episode were also recorded.

The NIHSS (range 0–42; higher scores indicated more severe impairment) was used to quantify neurological deficit at presentation. Early improvement was defined as a 24-hour neurological assessment score better than the admission score. Intracranial bleeding, survival and disability based on the mRS were then assessed in symptomatic cases. The clinical observations were studied and correlated with the collateral category assigned on initial CTA.

Neuroimaging Protocol and CT Angiographic Evaluation

Acute imaging pathway included noncontrast brain CT and then CTA of the cervical and intracranial arteries. Source images, multiplanar reformats of the images and maximum intensity projections were used to assess collateral enhancement and the occluded segment. Occlusions were categorized according to anatomic location as intracranial internal carotid artery occlusion, M1 middle cerebral artery (MCA) occlusion, or proximal M2 MCA occlusion.

Parenchymal ischemic changes were assessed using a noncontrast CT performed within 24 hours of the onset of symptoms. The Alberta Stroke Program Early CT Score (ASPECTS) was determined using the 0-10 point scale; a higher score reflects a lower amount of early ischemic changes.

The degree of collateral filling was assessed by the four-tiered CTA approach of Tan et al. [3] with the unaffected middle cerebral artery territory as the reference point. The grades were as follows: grade 0—no visible collateral enhancement; grade 1—filling less than half of the affected area; grade 2—filling more than half but not the entire affected area; and grade 3—full filling. Analysis was done between poor collateral status (grades 0–1) and good collateral status (grades 2–3). This original categorization was then compared to the neurological, imaging, and functional assessments performed.

Acute Stroke Management

Acute management was left to the stroke management team depending on the examination of the patient, the imaging of the vessels, the time of onset of the symptoms, and the suitability of reperfusion and available resources in each institution. Based on clinical indication, patients underwent intravenous thrombolysis, mechanical thrombectomy, or nonreperfusion medical care. Allotted to treatment for comparison across collateral group. Reperfusion was defined using the modified Thrombolysis in Cerebral Infarction (mTICI) score, with mTICI score grade 2b–3 considered as good reperfusion.

Outcome Assessment

The primary endpoint was independence in daily functioning 90 days after the stroke, defined as an mRS score of 0–2. The disability rating is a scale from 0 (no residual symptoms) to 6 (death). Available follow-up records were used to obtain follow-up status at clinical review or by structured telephone contact. Outcomes were divided into independent (mRS 0–2) or dependent or deceased (mRS 3–6).

Secondary outcomes included neurological improvement at 24 hours, symptomatic intracranial hemorrhage, and death within 90 days. Improvement was defined as a reduction in NIHSS score of ≥ 4 points from baseline or an NIHSS score of 0-1 at 24 hours. The presence of symptomatic intracranial hemorrhage was defined by combining the clinical and imaging records by means of the Heidelberg Bleeding Classification [15]. Mortality was determined based on hospital records and follow-up. Comparisons were made of the number of times each endpoint occurred in the two original collateral groups.

Statistical Analysis

Data were analysed using IBM SPSS Statistics 26. For numerical measurements, the mean and standard deviation or the median and interquartile range were used respectively, depending on the distribution of the data. Normality was examined by means of graphical inspection and the Shapiro–Wilk test. Categorical data were presented as percentages and numbers. Independent-samples t testing was employed for approximately normally distributed continuous measurements, and chi-square or Fisher exact testing was employed for categorical outcomes as appropriate. Two-sided $P<0.05$ was considered statistically significant.

First, an unadjusted association between the collateral category and independence at day 90 was evaluated with a binary logistic regression model. The adjusted model comprised collateral category, age, initial NIHSS, baseline ASPECTS, occlusion of the intracranial internal carotid artery, and endovascular thrombectomy. The comparator category was poor collateral status. Effect estimates are presented as crude or adjusted odds ratios with corresponding 95% confidence intervals. The model coefficients were interpreted as associations, not as cause and effect, due to not being randomly assigned.

Ethical Considerations

The study was conducted in accordance with the ethical principles of the Declaration of Helsinki. Ethical approval was obtained from the relevant Institutional Review Board before study initiation. Written informed consent was obtained from all participants. Confidentiality, anonymity, and voluntary participation were maintained throughout the study.

RESULTS

Demographic and clinical characteristics at baseline.

The current study enrolled 150 participants. Assessment of baseline CTA showed good collateral filling in 86 individuals (57.3%) and poor collateral filling in 64 (42.7%). The good-collateral group had a median age of 64 years (IQR 57–72), compared with 67 years (IQR 58–75) in the poor-collateral group (P=0.286). Men accounted for 58.1% and 60.9%, respectively (P=0.740). Hypertension was the leading recorded vascular risk factor, affecting 54/86 (62.8%) and 38/64 (59.4%) participants (P=0.736). Diabetes (29.1% vs. 26.6%; P=0.854), atrial fibrillation (24.4% vs. 28.1%; P=0.707), and current smoking (23.3% vs. 28.1%; P=0.570) showed no statistically significant group differences. Baseline demographic patterns, vascular comorbidities, and recruitment-center distribution are detailed in Table 1.

Table 1. Baseline demographic and clinical characteristics according to CTA collateral status (n=150)

Variable	Good collaterals (n=86)	Poor collaterals (n=64)	P-value
Age, years, median (IQR)	64 (57–72)	67 (58–75)	0.286
Male sex	50 (58.1%)	39 (60.9%)	0.740
Female sex	36 (41.9%)	25 (39.1%)	—
Hypertension	54 (62.8%)	38 (59.4%)	0.736
Diabetes mellitus	25 (29.1%)	17 (26.6%)	0.854
Atrial fibrillation	21 (24.4%)	18 (28.1%)	0.707
Current smoking	20 (23.3%)	18 (28.1%)	0.570
Recruitment center, overall			1.000
DHQ Hospital, Nankana Sahib	48 (55.8%)	36 (56.3%)	
Allied Hospital, Faisalabad	38 (44.2%)	28 (43.8%)	

CTA, computed tomography angiography; IQR, interquartile range; DHQ, District Headquarters. Entries are n (%) except were stated otherwise. Categorical P-values are consistent with Fisher exact testing. Sex is represented by one group-comparison P-value.

Association of CTA Collateral Status with Stroke Severity and Radiological Characteristics

Initial neurological deficits differed markedly by collateral category. Median admission NIHSS was 12 (IQR 10–15) among patients with good collateral filling and 18 (IQR 15–21) among those with poor filling (P<0.001). Baseline ASPECTS also favored the good-collateral group: 8 (IQR 7–9) versus 7 (IQR 6–8; P<0.001). Thus, patients with better CTA filling had both lower clinical severity scores and fewer early ischemic changes on CT. Occlusion anatomy was unevenly distributed between groups (overall P=0.003). Intracranial internal carotid artery blockage occurred in 16.3% of good-collateral cases but 39.1% of poor-collateral cases. Conversely, proximal M2 occlusion occurred in 24.4% and 10.9%, respectively. M1 occlusion accounted for 59.3% of the good-collateral group and 50.0% of the poor-collateral group. The two groups had similar median intervals to CTA (240 and 241 minutes; P=0.848). Treatment frequencies were likewise comparable: intravenous thrombolysis was delivered to 44.2% versus 45.3% (P=1.000), and thrombectomy to 64.0% versus 60.9% (P=0.735). Detailed imaging and treatment comparisons appear in Table 2.

Table 2. Association of CTA collateral status with neurological severity, imaging findings, and acute stroke treatment

Variable	Good collaterals (n=86)	Poor collaterals (n=64)	P-value
Admission NIHSS, median (IQR)	12 (10–15)	18 (15–21)	<0.001
ASPECTS, median (IQR)	8 (7–9)	7 (6–8)	<0.001
Time to CTA, minutes, median (IQR)	240 (160–303)	241 (179–293)	0.848
Arterial occlusion site, overall			0.003
Intracranial internal carotid artery	14 (16.3%)	25 (39.1%)	
M1 middle cerebral artery	51 (59.3%)	32 (50.0%)	
Proximal M2 middle cerebral artery	21 (24.4%)	7 (10.9%)	
Intravenous thrombolysis	38 (44.2%)	29 (45.3%)	1.000
Endovascular thrombectomy	55 (64.0%)	39 (60.9%)	0.735

CTA, computed tomography angiography; NIHSS, National Institutes of Health Stroke Scale; ASPECTS, Alberta Stroke Program Early CT Score; IQR, interquartile range. Figures are n (%) unless labeled otherwise. Pearson chi-square testing is consistent with the overall occlusion-site comparison, and Fisher exact testing with the treatment comparisons.

Association of Collateral Status with Early Neurological Recovery and 90-Day Functional Outcomes

By day 90, 60 of 86 patients (69.8%) with good collateral filling had reached mRS 0–2, compared with 17 of 64 patients (26.6%) with poor filling (P<0.001). The corresponding numbers with dependence or death (mRS 3–6) were 26 (30.2%) and 47 (73.4%). Median follow-up mRS was 2 (IQR 1–3) in the good-collateral category and 4 (IQR 2–5) in the poor-collateral category (P<0.001), indicating a marked difference in recorded functional disability.

Improvement in the first 24 hours was observed in 54/86 patients (62.8%) with good collaterals and 21/64 (32.8%) with poor collaterals (P<0.001). Symptomatic intracranial hemorrhage was documented in 3 (3.5%) and 7 (10.9%), respectively; this contrast did not reach conventional statistical significance (P=0.099). At 90 days, 3 (3.5%) participants with good filling and 10 (15.6%) with poor filling had died (P=0.016). Table 3 summarizes the early neurological and later clinical outcomes.

Table 3. Early neurological recovery and 90-day functional outcomes according to CTA collateral status

Clinical outcome	Good collaterals (n=86)	Poor collaterals (n=64)	P-value
Functional independence (mRS 0–2)	60 (69.8%)	17 (26.6%)	<0.001
Unfavorable outcome (mRS 3–6)	26 (30.2%)	47 (73.4%)	<0.001
Median 90-day mRS (IQR)	2 (1–3)	4 (2–5)	<0.001
Early neurological improvement	54 (62.8%)	21 (32.8%)	<0.001
Symptomatic intracranial hemorrhage	3 (3.5%)	7 (10.9%)	0.099
All-cause mortality at 90 days	3 (3.5%)	10 (15.6%)	0.016

Abbreviations: CTA, computed tomography angiography; mRS, modified Rankin Scale; IQR, interquartile range. Unless specified, values are n (%). Fisher exact testing is consistent with the categorical comparisons.

Multivariable Logistic Regression Analysis of Factors Associated with Functional Independence

In the unadjusted logistic model, baseline good collateral status was strongly associated with 90-day independence. The estimated odds ratio was 6.38 (95% CI 3.10–13.12; P<0.001), using poor collateral status as the reference. After inclusion of age, admission NIHSS, ASPECTS, intracranial internal carotid occlusion, and thrombectomy in the model, the association remained evident (adjusted OR 2.79; 95% CI 1.17–6.65; P=0.021). Each additional point on the admission NIHSS corresponded to lower odds of independence (adjusted OR 0.88; 95% CI 0.81–0.95; P=0.001). A one-point increase in ASPECTS was associated with higher odds (adjusted OR 1.54; 95% CI 1.18–2.02; P=0.002), as was receipt of thrombectomy (adjusted OR 2.54; 95% CI 1.09–5.93; P=0.031). Neither age (adjusted OR 0.98 per year; 95% CI 0.94–1.01; P=0.132) nor intracranial internal carotid artery occlusion (adjusted OR 0.71; 95% CI 0.27–1.87; P=0.487) met the statistical significance threshold in this model. Table 4 gives the complete adjusted estimates.

Table 4. Multivariable logistic regression analysis of factors associated with 90-day functional independence (mRS 0–2)

Predictor	Adjusted OR	95% CI	P-value
Good collateral circulation	2.79	1.17–6.65	0.021
Age, per year	0.98	0.94–1.01	0.132
Admission NIHSS, per point	0.88	0.81–0.95	0.001
Baseline ASPECTS, per point	1.54	1.18–2.02	0.002
Intracranial ICA occlusion	0.71	0.27–1.87	0.487
Endovascular thrombectomy	2.54	1.09–5.93	0.031

OR, odds ratio; CI, confidence interval; NIHSS, National Institutes of Health Stroke Scale; ASPECTS, Alberta Stroke Program Early CT Score; ICA, internal carotid artery; mRS, modified Rankin Scale. The analysis contains the six predictors shown. Comparator levels are poor collaterals, no intracranial ICA occlusion, and no thrombectomy.

Taken together, the clinical, imaging, and follow-up findings show that good CTA collateral filling was associated with less severe stroke at presentation and more favorable disability outcomes. The relationship seen with 90-day independence remained in the reported model, which adjusted for some selected baseline and treatment factors. These results suggest that collateral grade should be used in the prognostic assessment, but not as a stand-alone parameter.

DISCUSSION

The principal finding was the substantial difference in 90-day recovery between patients with good and poor collateral filling on baseline CTA. The rate of Independence (mRS 0–2) was 69.8% in the good-collateral group compared with 26.6% in the poor-collateral group (P<0.001). Improved collaterals were also associated with less severe neurological impairment (lower admission NIHSS) and fewer early ischemic changes (higher admission ASPECTS). Independent of the selected clinical, imaging, and treatment measures, the association with independence remained (adjusted OR 2.79; 95% CI 1.17–6.65). These results support the use of collateral status as additional prognostic information, instead of a standalone parameter of stroke prognosis [1–3].

A plausible physiological explanation is the persistence of inflow from ischemic areas via leptomeningeal arterial connections which are supplied outside of the blocked artery. This flow may maintain some perfusion to threatened tissue and may prevent expansion of the infarct, although this was not directly measured in the current cohort [4]. The median NIHSS for the better-collateral group was 12 (vs. 18, P<0.001) and median ASPECTS was 8 (vs. 7, P<0.001). This is in line with the overall published literature on the relationship between collateral adequacy and the extent of initial ischemic injury, although in this data set there was no direct causal link shown between collateral adequacy and the extent of initial ischemic injury [5].

These results of functional independence are generally consistent with previous studies on stroke imaging with good collaterals. The IMS III analysis by Menon and colleagues considered the relationship between CTA collateral features and clinical outcome [6], and pooled evidence from endovascular cohorts has similarly associated more favorable collateral patterns with improved recovery [7]. Vascular imaging can play a role in decisions for reperfusion and subsequent treatment time windows as demonstrated by trials such as ESCAPE and MR CLEAN-LATE [8]. These studies vary in terms of eligibility criteria, imaging techniques and treatment setting; however, collateral grade is part of a bigger picture that includes deficits severity, infarct burden, occlusion features, and clinical guidelines [9].

Favorable collateral status was also correlated with higher rates of early neurological improvement (62.8% vs. 32.8%; P<0.001) and lower death rates up to day 90 (3.5% vs. 15.6%, P=0.016). There was also a numerical difference in the incidence of symptomatic intracranial hemorrhage between the two groups, with the good-collateral group exhibiting a lower incidence (3.5% vs. 10.9%), although this was not statistically significant (P=0.099). The endpoints are influenced by tissue injury, success of reperfusion, timing of treatment and complications that could follow, and the group differences observed should not be interpreted as due to the collateral circulation alone [10,11].

After adjusting for age, baseline NIHSS, ASPECTS, intracranial carotid occlusion and thrombectomy, an association between good collateral grade and independence remained. Higher NIHSS scores were associated with worse outcome (adjusted OR 0.88 per point change in NIHSS), while higher ASPECTS (adjusted OR 1.54 per point change in ASPECTS) and thrombectomy (adjusted OR 2.54) were associated with better outcome. As the cohort was observational, unmeasured confounding and nonrandom treatment selection preclude causal conclusions, particularly about the effect of thrombectomy [9,12].

The most important implication is that collateral assessment can provide prognostic information beyond routine neurological examination and parenchymal CT in the setting of a clinically appropriate CTA. However, caution must be used when interpreting. Precision and transferability are limited by the small sample size, low number of hemorrhagic events and fatalities, and variable CTA acquisition across centres [13–17]. Delayed contrast arrival can lead single-phase CTA to underestimate collateral recruitment, while unavailable perfusion and ischemic-core measurements prevented a fuller assessment of tissue status [18]. Additional prospective studies with uniform imaging and full follow-up and external validation of prediction models are required to define the added value of CTA collateral grading [19,20].

CONCLUSION

In anterior-circulation ischemic stroke patients, good collateral filling on admission CTA was correlated with less neurologic severity, higher ASPECTS, increased chances of early improvement, reduced observed 90-day mortality, and greater rates of functional independence. This association was still present after adjusting for selected clinical and treatment characteristics, with reference to 90-day mRS 0–2. CTA collateral grading can therefore be used as a complementary tool for prognostic evaluation, but these are observational data and do not prove causality.

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