Unfavorable clinical outcomes in patients with good collateral scores following endovascular treatment for acute ischemic stroke of the anterior circulation: The UNCLOSE study

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Unfavorable clinical outcomes in patients with good collateral scores following endovascular treatment for acute ischemic stroke of the anterior circulation: The UNCLOSE study

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Introduction

- Good collaterals represent a hemodynamic reservoir for ischemic areas due to large vessel occlusions (LVOs).
- Therefore, patients with good collaterals are considered the most suitable candidates for MT.
- Poor clinical outcomes are observed also in patients with a good collateral profile.

Introduction

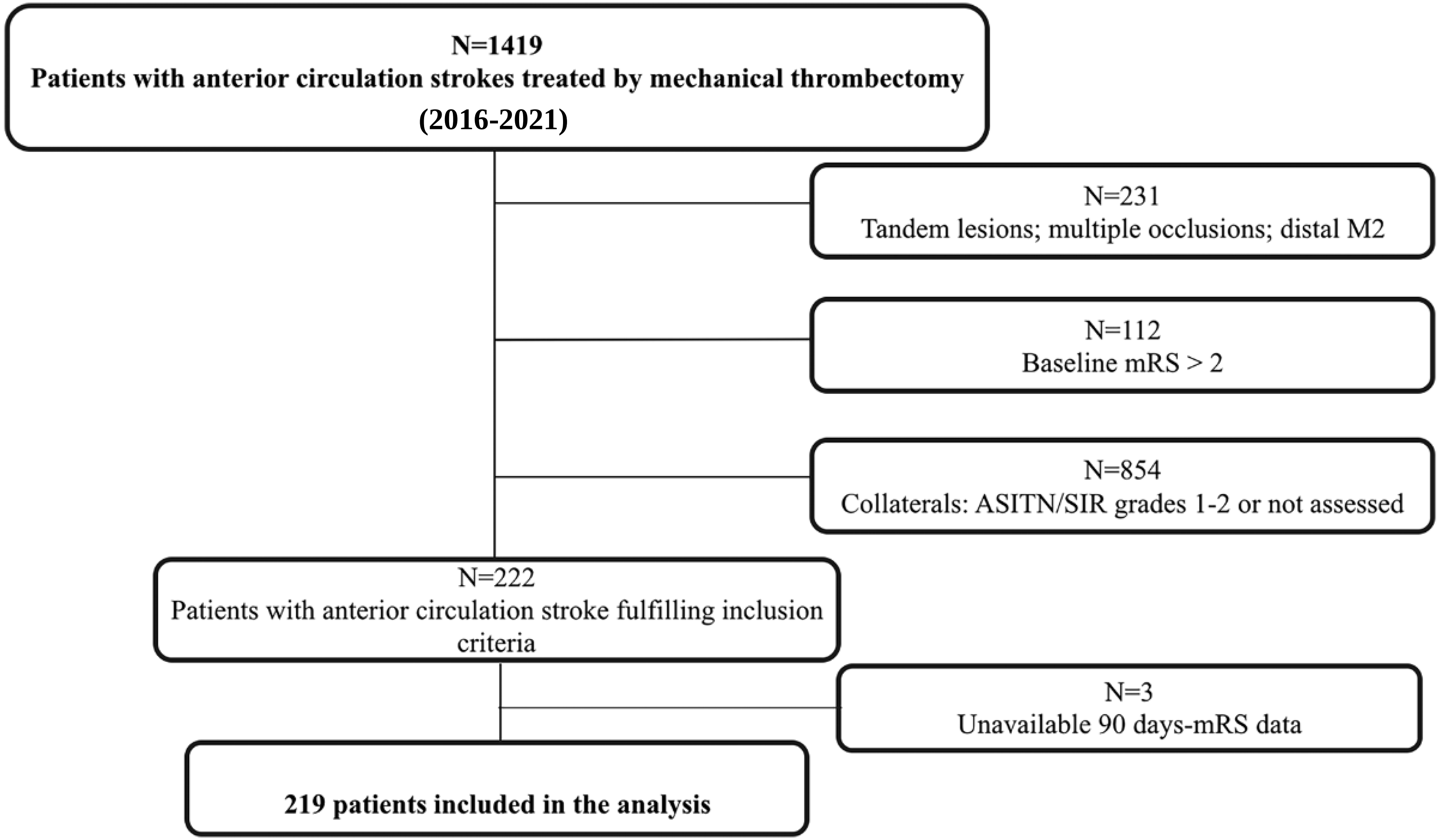
- The aim of this paper was to analyze the factors associated with poor clinical outcome in patients with a potentially favorable profile based on the presence of a good collateral circulation

Materials and methods

Study cohort

- All consecutive patients with acute ischemic stroke of the anterior circulation who underwent MT from January 1, 2016 to December 31st 2021 at our institution were retrospectively analyzed from a prospectively collected, web-based registry (ETIS Registry, NCT03776877).

Study Flow Chart



Variables

Females, N(%)
Age, mean ± SD
Baseline mRS, N(%)
 0
 1
 2
Baseline NIHSS, median (IQR)
Occlusion site, N(%)
 ICA terminus
 M1-MCA
 Proximal M2
Side, N(%)
 Left
 Right
Baseline ASPECTS, median (IQR)
Secondary transfer, *N*(%)
Onset-to-groin, mean ± SD
Onset-to-recanalization, mean ± SD
Groin-to-recanalization, mean ± SD
IVT, *N*(%)

Anesthesia protocol, N(%)
 General anesthesia
 Conscious sedation
 Local anesthesia
BGC used, *N*(%)
First-line strategy, N(%)
 Aspiration
 Stent retriever/combined
First pass effect
No of passes, mean ± SD
mTICI, N(%)
 2b-3
 2c-3
Complications, *N*(%)
24h-NIHSS, median (IQR)
24h-ASPECTS, median (IQR)
PH1/PH2
sICH, *N*(%)
Recurrent stroke, *N*(%)

Definitions

- The first pass effect (FPE): FPE is defined as achieving a complete recanalization with a single thrombectomy device pass.
- Recanalization grade according to the modified treatment in cerebral infarction (mTICI) scale.

✓Partial (mTICI 0-2a),

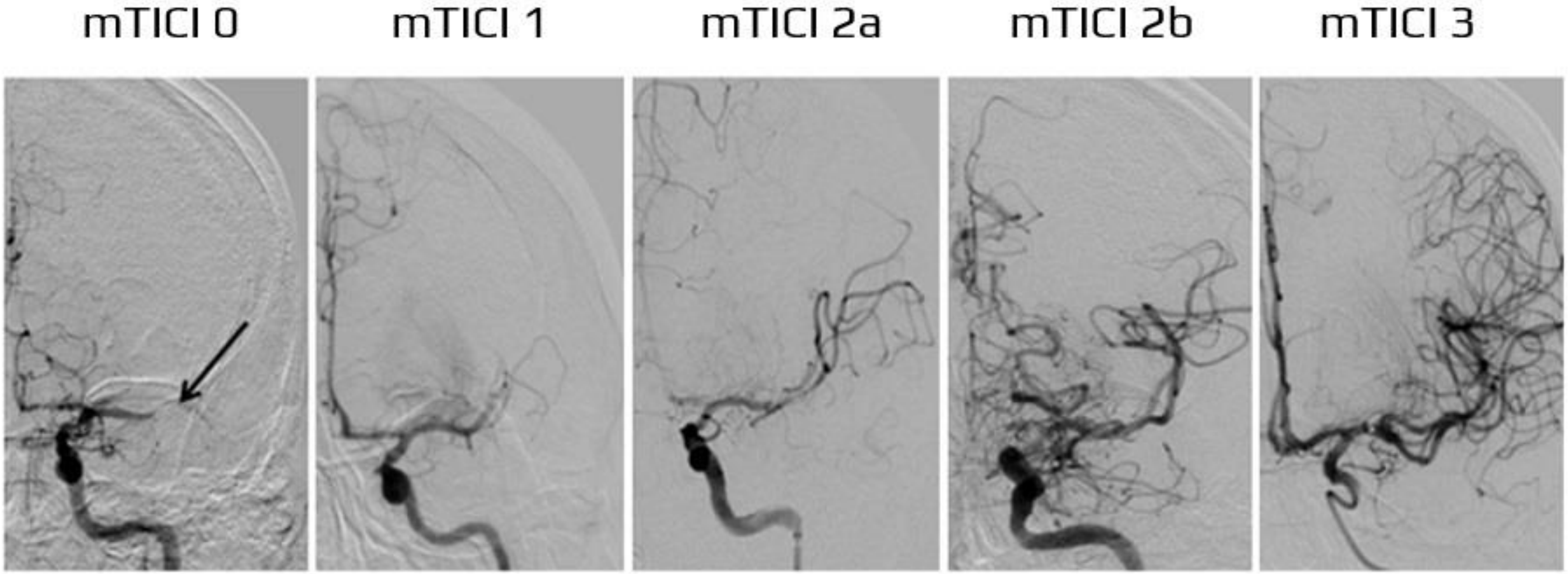
✓Adequate (mTICI 2b-3)

✓Almost complete/complete (mTICI 2c-3).

The (mTICI) scale

TICI Grade	Original TICI	Modified TICI	Modified TICI With 2c
0/1	No/minimal reperfusion	No/minimal reperfusion	No/minimal reperfusion
2a	Partial filling <2/3 territory	Partial filling <50% territory	Partial filling <50% territory
2b	Partial filling ≥2/3 territory	Partial filling ≥50% territory	Partial filling ≥50% territory
2c	…	…	Near complete perfusion except slow flow or few distal cortical emboli
3	Complete perfusion	Complete perfusion	Complete perfusion

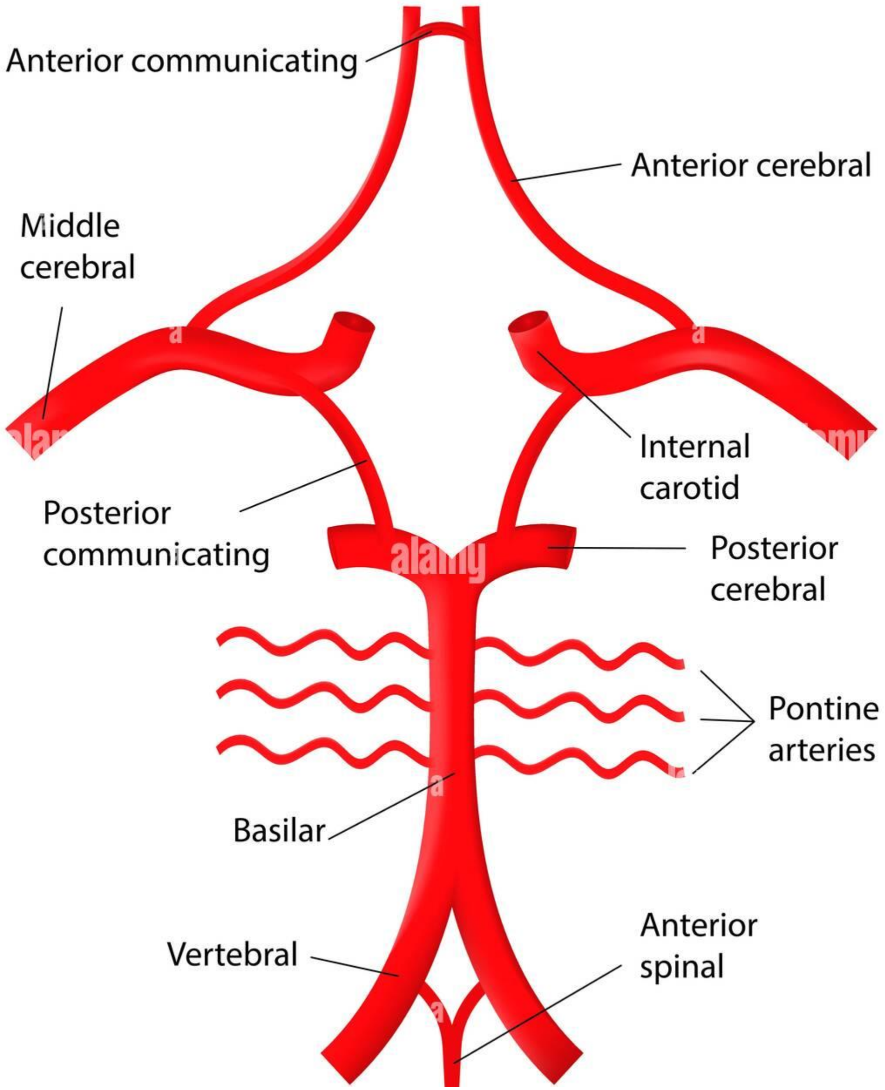
mTICI



American Society for Interventional and Therapeutic Neuroradiology/Society of Interventional Radiology (ASITN/SIR) scale.

Grade 0	No collaterals visible to the ischemic site
Grade 1	Slow collaterals to the periphery of the ischemic site with persistence of some of the defect
Grade 2	Rapid collaterals to the periphery of ischemic site with persistence of some of the defect and to only a portion of the ischemic territory
Grade 3	Collaterals with slow but complete angiographic blood flow of the ischemic bed by the late venous phase
Grade 4	Complete and rapid collateral blood flow to the vascular bed in the entire ischemic territory by retrograde perfusion

* Collateral circulation was assessed on the pre-thrombectomy angiographic study, with injection from ipsilateral ICA (for M1 and proximal M2 occlusions) or contralateral ICA and posterior circulation (for intracranial ICA occlusions).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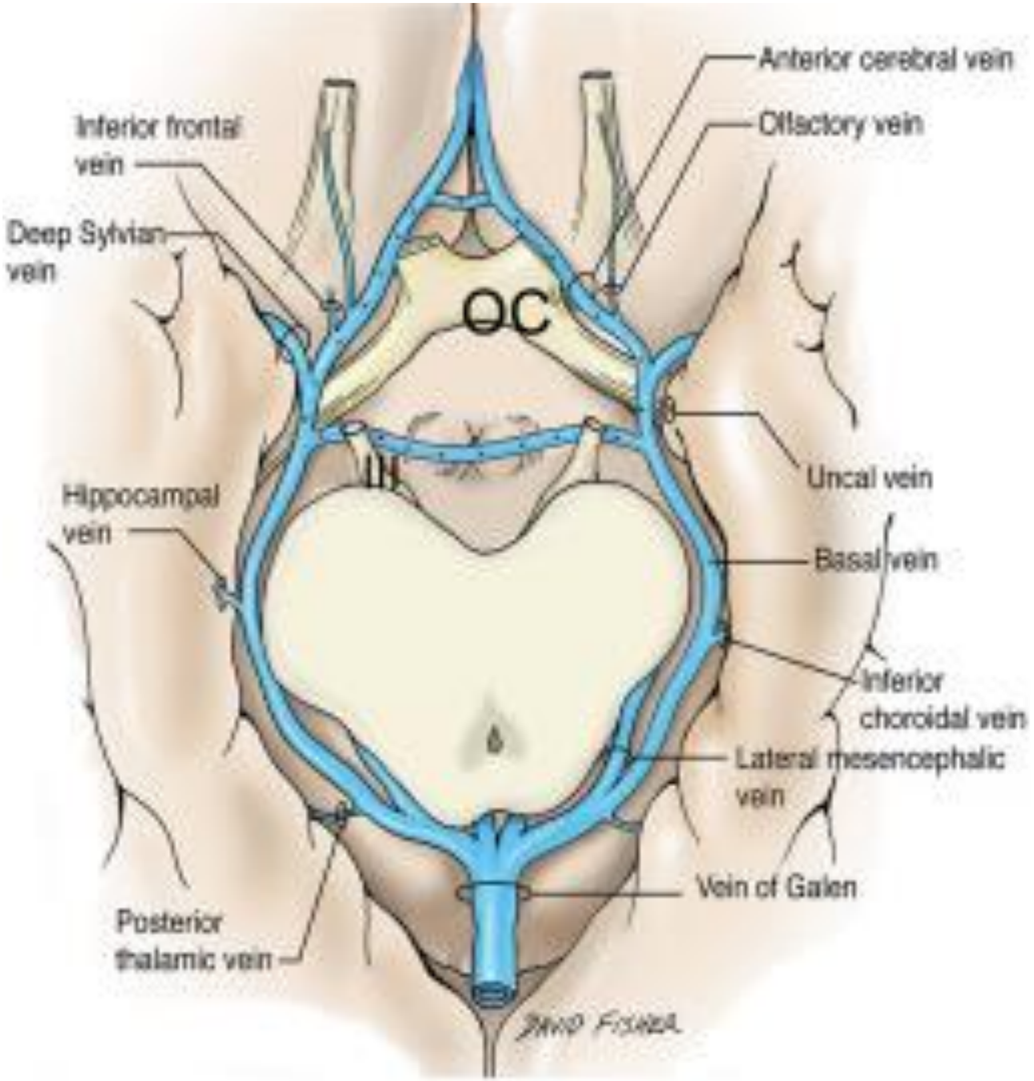
Anterior cerebral
Middle cerebral
Internal carotid
Posterior communicating
Posterior cerebral
Pontine arteries
Basilar
Vertebral
Anterior spinal


Anterior cerebral vein
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Inferior frontal vein
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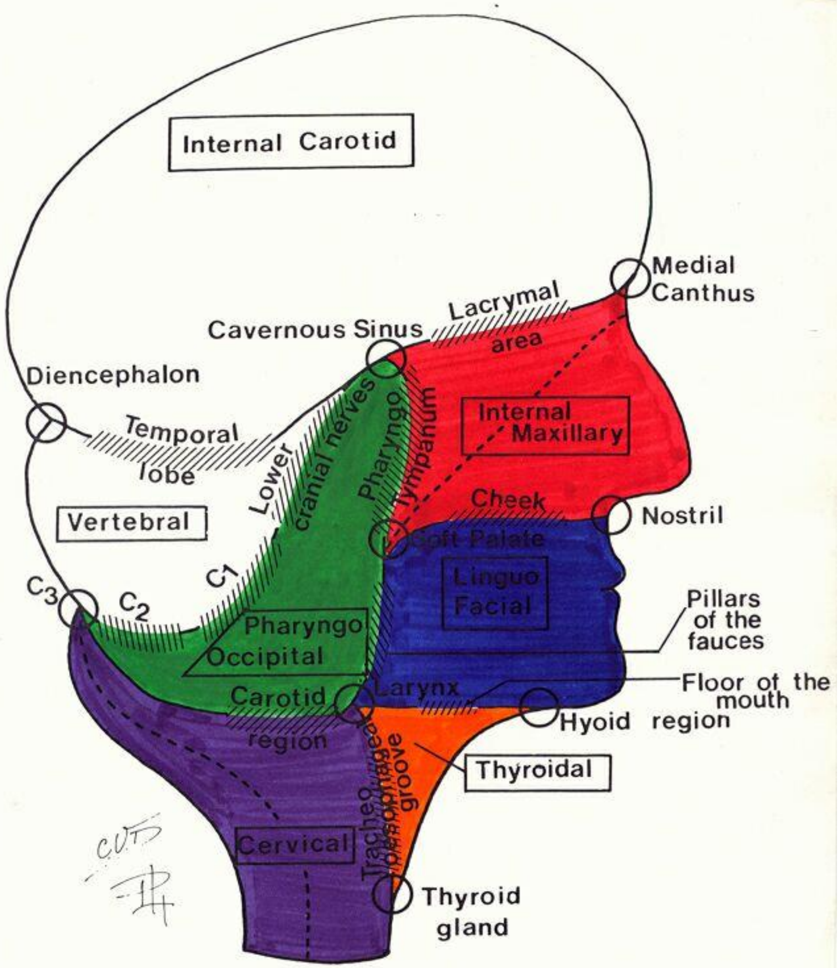
Basal vein
Inferior choroidal vein
Lateral mesencephalic vein
Vein of Galen
Posterior thalamic vein



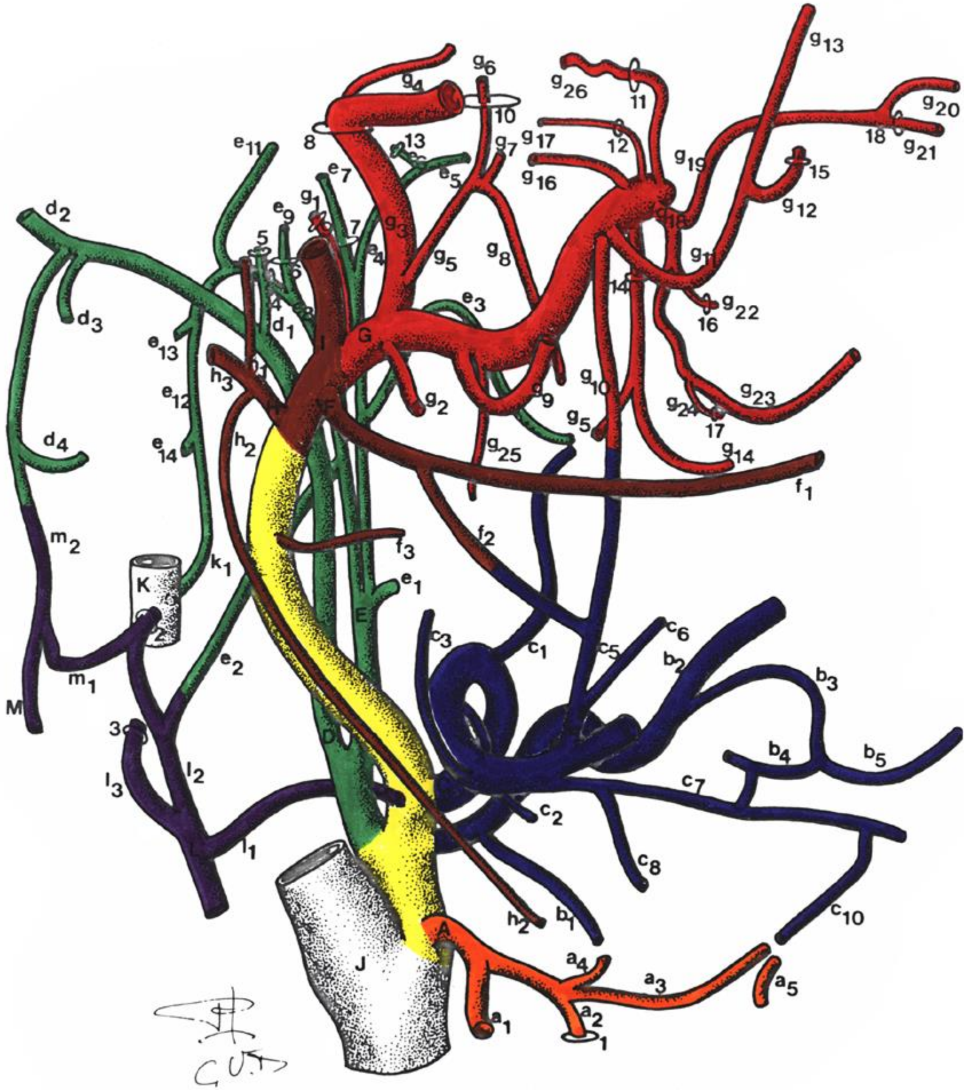
Head and Neck Arterial Territories :

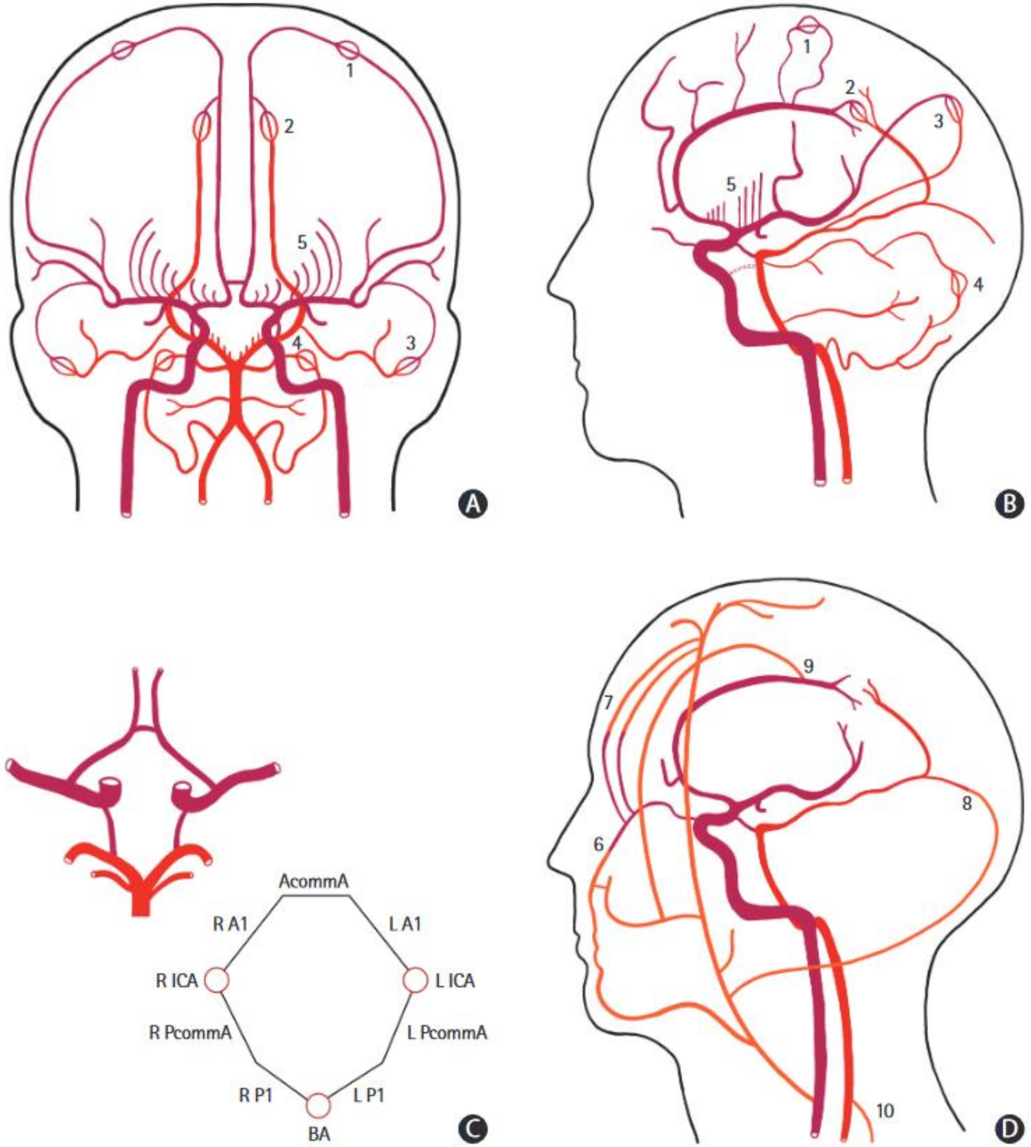
main arterial supply

territorial boundaries

critical areas of hemodynamic balance

ARTERES CERVICO FACIALES

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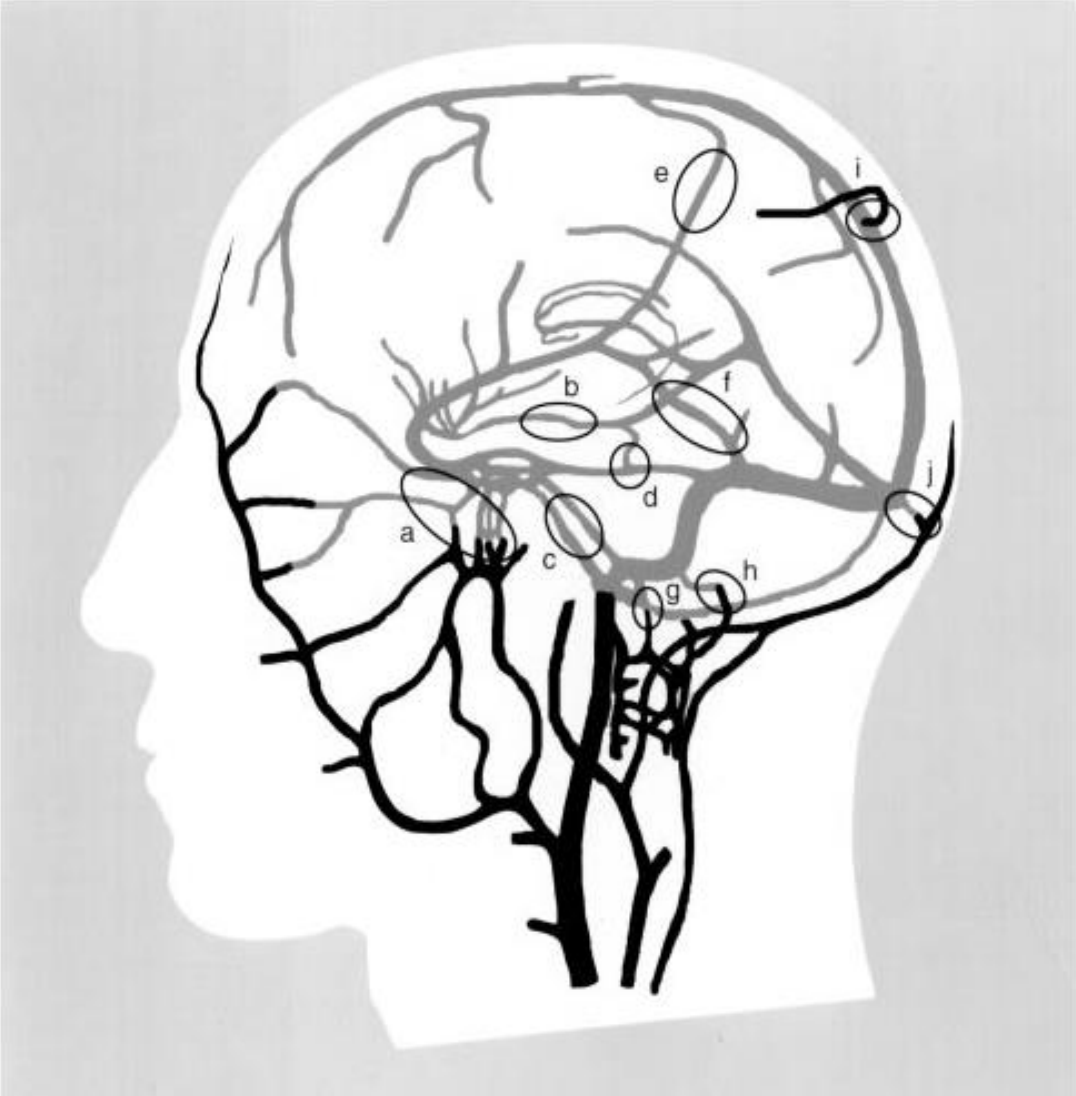
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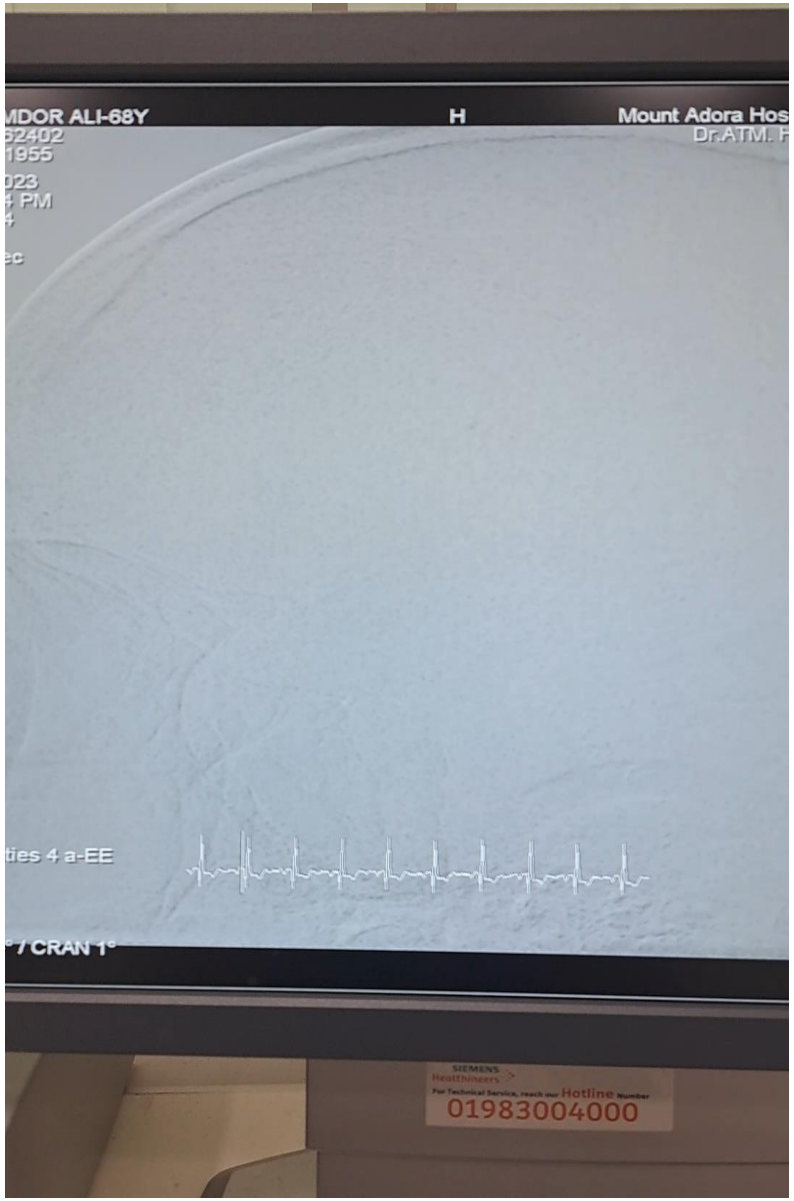
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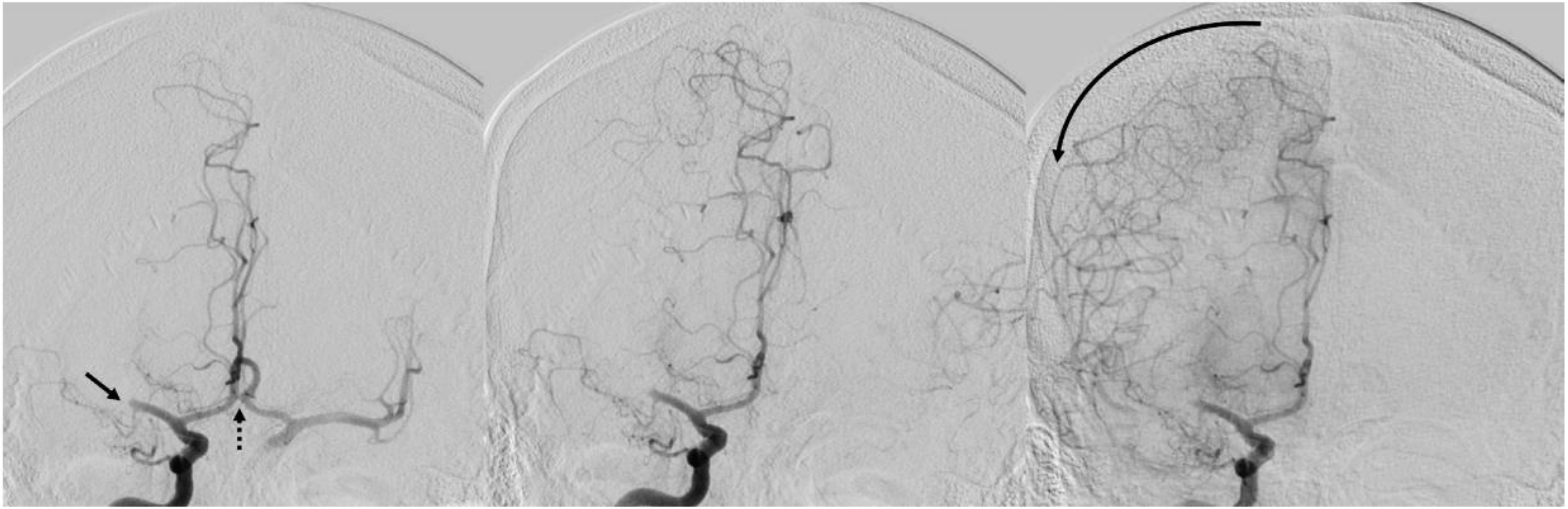

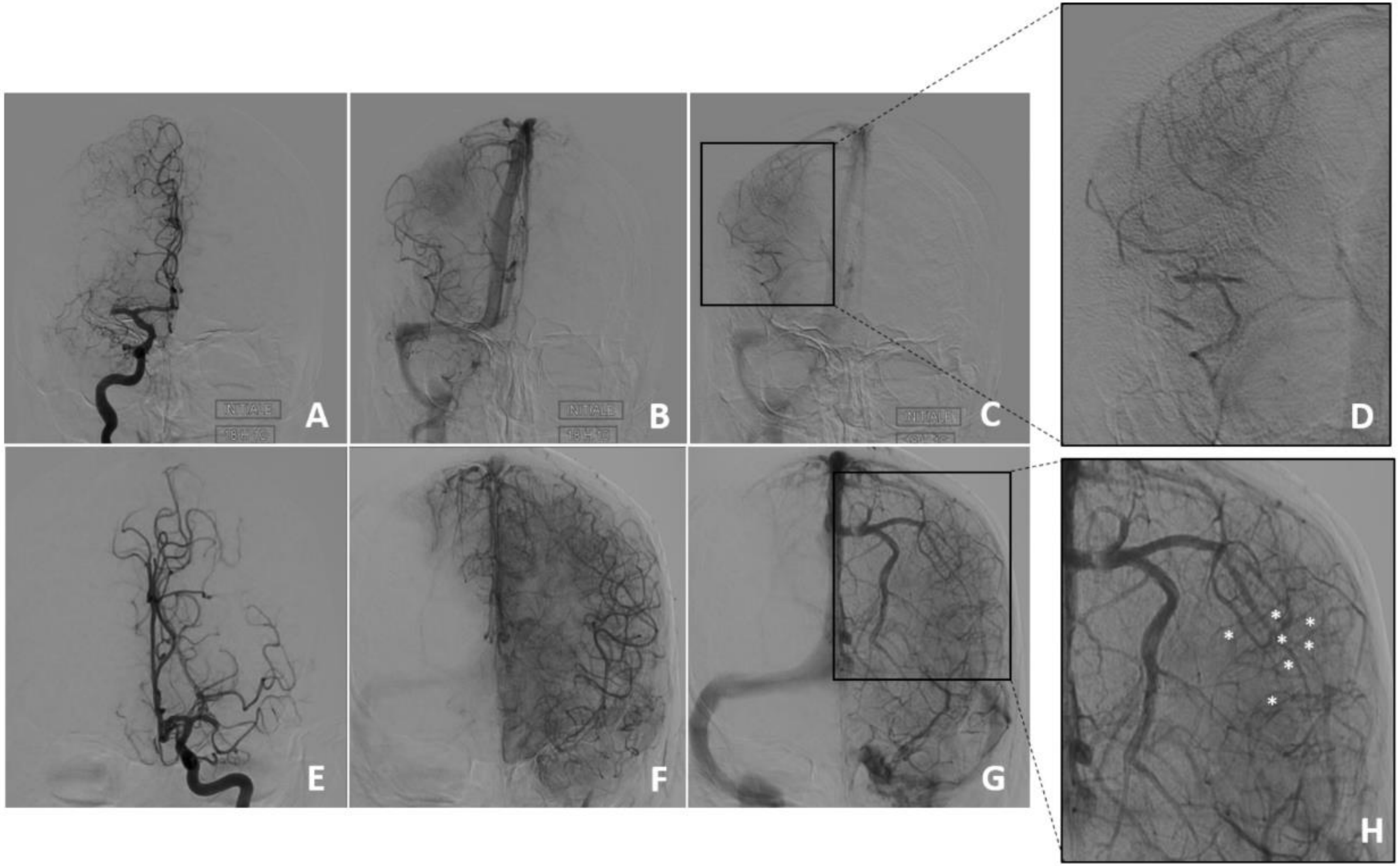
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Hemorrhagic transformation and symptomatic intracerebral hemorrhage (sICH) according to the ECASS definition

Types of HT	Mass effect	Definition
Hemorrhagic infarction-1 (HI-1)	Absence of mass effect	Small petechial bleeding along the margins of the infarcted area
Hemorrhagic infarction-2 (HI-2)		Confluent petechial bleeding within the infarcted area
Parenchymal hemorrhage-1 (PH-1)	Mildmass effect	Hematoma in <30% of the infarcted area
Parenchymal hemorrhage-2 (PH-2)	Definite mass effect	Hematoma in more than 30% of the infarcted area

Inclusion Criteria

1. Age $\geq$ 18
2. Acute LVO in the anterior circulation (intracranial internal carotid and M1 or proximal M2 segments of the middle cerebral artery)
3. Good collateral circulation which was defined as grades 3 and 4 of the American Society for Interventional and Therapeutic Neuroradiology/Society of Interventional Radiology (ASITN/SIR) scale

Exclusion Criteria

1. Patients with tandem or multiple occlusions
2. Significant pre-stroke disability defined as modified Rankin Scale (mRS) >2
3. Patients with incomplete and unavailable follow-up data

Collateral circulation assessment

- The ASITN/SIR scale was used for the evaluation.
- Interventional images were retrospectively reviewed by an interventional neuroradiologist and an interventional neurologist with ≥5 years of experience in the neurointerventional field.
- A third neurointerventionalist with >10 years of experience reviewed all the angiograms and resolved the disagreements.
- Kappa inter- and intra-observer agreement was calculated per grade and per dichotomization (grades 1-2 vs grades 3-4).

Endpoints

- **The primary endpoint** was to investigate the factors associated with unfavorable outcome defined as the lack of achievement of a functional independence (mRS 3-6) at 90-days outpatient visit or telephone interview.

- **Secondary endpoint** included the analysis of those factors associated with unfavorable outcome in adequately recanalized (defined as mTICI 2b-3) patients, all-causes mortality at 90-days and post-procedural symptomatic intracerebral hemorrhage (sICH) in the over all population.

Statistical analysis

- Statistical analysis was performed with the SAS 9.4 software.
  - ✓Student’s T-tests or Wilcoxon tests were performed for continuous variables.
  - ✓Chi square test or Fisher’s test were used for categorical variables.
  - ✓Univariate and multivariate logistic regression model.
  - ✓The Area under the Curve (AUC) for statistical validity.
  - ✓Variance Inflation Factor (VIF) to asses multi-collinearity.

Results

Table 1. Overall study population data and univariate analysis (primary endpoint).

	Overall *(N = 219)*	Favorable outcome *(N = 116)*	Unfavorable outcome *(N = 103)*	*p*
Females, N(%)	117 (53.4)	56 (48)	46 (45)	0.59
Age, mean ± SD	70.6 ± 16	65.3 ± 16.9	76.6 ± 12.9	<0.001
Baseline mRS, N(%)				
0	181 (82)	105 (91)	76 (74)	<0.001
1	23 (10)	11 (9)	12 (12)	
2	15 (7)	0	15 (14)	
Baseline NIHSS, median (IQR)	15 (9–19.25)	12 (7–17)	18 (14–21)	<0.001
Occlusion site, N(%)				
ICA terminus	14 (6)	6 (5)	8 (8)	0.21
M1-MCA	165 (74)	83 (72)	82 (79)	
Proximal M2	40 (18)	27 (23)	13 (13)	
Side, N(%)				
Left	115 (53)	62 (53)	53 (51)	0.76
Right	104 (47)	54 (47)	50 (50)	
Baseline ASPECTS, median (IQR)	8 (7–9)	8 (7–9)	8 (7–9)	0.1
Secondary transfer, *N*(%)	132 (60)	63 (54)	69 (67)	0.06
Onset-to-groin, mean ± SD	230.12 ± 113.09	225.5 ± 82.8	239.7 ± 87.1	0.22
Onset-to-recanalization, mean ± SD	288.3 ± 117.3	270.4 ± 93	299.4 ± 96	0.03
Groin-to-recanalization, mean ± SD	53.8 ± 41.1	46.3 ± 32.7	63.1 ± 47.6	0.004
IVT, *N(%)*	116 (53)	72 (62)	44 (43)	0.004

Table 1. Overall study population data and univariate analysis (primary endpoint).

	Overall *(N = 219)*	Favorable outcome *(N = 116)*	Unfavorable outcome *(N = 103)*	*p*
Anesthesia protocol, N(%)				
General anesthesia	38 (17)	16 (14)	22 (21)	0.12
Conscious sedation	157 (72)	90 (78)	67 (65)	
Local anesthesia	24 (11)	10 (9)	14 (14)	
BGC used, *N*(%)	61 (28)	38 (33)	23 (22)	0.09
First-line strategy, N(%)				
Aspiration	137 (63)	69 (59)	68 (66)	0.08
Stent retriever/combined	82 (37)	47 (41)	35 (34)	
First pass effect	89 (41)	50 (43)	39 (38)	0.43
No of passes, mean ± SD	2.3 ± 2	2 ± 1.3	2.7 ± 2.5	0.01
mTICI, N(%)				
2b-3	194 (89)	109 (94)	85 (82)	0.002
2c-3	153 (70)	89 (77)	64 (62)	
Complications, *N*(%)	26 (12)	15 (13)	11 (11)	0.63
24h-NIHSS, median (IQR)	8 (3–17)	4 (2–8)	16.5 (11–20.75)	<0.001
24h-ASPECTS, median (IQR)	7 (6–8)	7 (5–8)	6 (3–8)	<0.001
PH1/PH2	30 (13.6)	10 (8.6)	20 (20)	0.02
sICH, *N*(%)	13 (6)	0	13 (13)	<0.001
Recurrent stroke, *N*(%)	11 (5)	3 (3)	8 (8)	0.09

BGC: balloon guiding catheter; ICA: internal carotid artery; IQR: interquartile range; IVT: intravenous thrombolysis; MCA: middle cerebral artery; mRS: modified Rankin Scale; SD: standard deviation; sICH: symptomatic intracerebral hemorrhage; PH1/PH2: parenchymal hemorrhage type 1 and 2 according to the ECASS-III classification; ASPECTS: DWI-Alberta Stroke Program Early CT Score; mTICI: modified treatment in cerebral infarction.

Table 2. Secondary endpoints.

	Recanalized patients (2b-3)			*Mortality*			*sICH*[a]		
	Favorable outcome *(mRS 0–2, N = 110)*	*Unfavorable outcome (mRS 3–6, N = 84)*	*p*	*Survival (N = 189)*	*Death (N = 30)*	*p*	*No sICH (N = 198)*	*sICH (N = 13)*	*p*
Sex (female), N(%)	58 (53)	46 (55)	0.78	102 (54)	15 (50)	0.6	105 (54)	7 (54)	0.9
Age, mean ± SD	64.8 ± 17.1	75.9 ± 13.7	<0.001	68.9 ± 16.5	81.2 ± 8,0	<0.001	69.9 ± 16.4	78.8 ± 7,7	0.06
Baseline mRS, N(%)									
0	99 (90)	64 (76)	<0.001	163 (86)	18 (60)	<0.001	168 (84)	9 (70)	0.13
1	11 (10)	7 (8)		19 (10)	4 (13)		20 (10)	2 (15)	
2	0	13 (16)		7 (4)	8 (27)		12 (6)	2 (15)	
Baseline NIHSS, median (IQR)	12 (7–17)	18 (15–21)	<0.001	8 (15–19)	19 (14.5–21.5)	0.002	15 (9–19)	19 (15–21)	0.05
Occlusion site									
ICA terminus	5 (4)	6 (7)	0.08	139 (74)	26 (86)	0.21	154 (77)	8 (61)	0.34
M1-MCA	80 (73)	69 (82)		38 (20%)	2 (7%)		34 (17%)	4 (31%)	
Proximal M2-MCA	25 (23)	9 (11)		12 (6%)	2 (7%)		12 (6%)	1 (8%)	
Side, N(%)									
Left	59 (54)	46 (55)	0.87	97 (51)	18 (60)	0.37	105 (53)	7 (54)	0.95
Right	51 (46)	38 (45)		92 (49)	12 (40)		93 (47)	6 (46)	
Baseline ASPECTS, median (IQR)	8 (7–9)	8 (7–9)	0.24	8 (7–9)	7 (7–8)	0.17	8 (7–9)	7 (5.75–8)	0.03
Secondary transfers, *N*(%)	59 (54)	58 (69)	0.03	115 (61)	17 (57)	0.66	119 (60)	8 (62)	1
Onset-to-groin, mean ± SD	218.7 ± 71.6	234 ± 80	0.18	233.5 ± 88.1	223.7 ± 62.6	0.83	233.2 ± 87.3	218.2 ± 64.6	0.63
Onset-to-recanalization, mean ± SD	263.8 ± 80	287.1 ± 91.8	0.07	283.1 ± 97.8	286.7 ± 77.6	0.53	282.2 ± 97.9	300.8 ± 64.3	0.14
Groin-to-recanalization, mean ± SD	45.1 ± 32.2	52.7 ± 39	0.16	51.7 ± 37,8	69.0 ± 56.5	0.35	51.8 ± 39.5	82.5 ± 51.3	0.03
IVT	70 (64)	38 (45)	0.01	106 (57)	10 (33)	0.02	108 (54)	4 (31)	0.1
Anesthesia protocol, N (%)									
General anesthesia	15 (14)	17 (20)	0.26	32 (17)	6 (20)	0.91	36 (18)	2 (15)	0.81
Conscious sedation	85 (77)	56 (67)		136 (72)	21 (70)		142 (71)	9 (70)	
Local anesthesia	10 (9)	11 (13)		21 (11)	3 (10)		22 (11)	2 (15)	
Use of BGC, *N*(%)	36 (33)	20 (24)	0.17	55 (29)	6 (20)	0.3	60 (30)	1 (8)	0.12
First-line strategy									
Aspiration	65 (59)	57 (68)	0.08	119 (63)	17 (59)	0.07	122 (61)	10 (77)	0.51
Stent retriever/Combined	45 (41)	27 (32)		70 (37)	12 (41)		77 (39)	3 (23)	
First pass effect, *N*(%)	50 (45)	39 (46)	0.89	79 (42)	10 (33)	0.38	86 (43)	1 (8)	0.01
No of passes, mean ± SD	1.9 ± 1.3	2.2 ± 1.6	0.11	2.2 ± 1.6	3.0 ± 3.6	0.36	2.3 ± 2.0	3.5 ± 2.0	0.01
mTICI									
0-2a	-	-	-	*17 (9)*	*8 (27)*	*0.01*	*20 (10)*	*5 (38)*	*0.01*
2b-3	-	-		*172 (91)*	*22 (73)*		*180 (90)*	*8 (62)*	

Table 2. Continued.

	Reconalized patients (2b-3)			*Mortality*			*sICH*[a]		
	Favorable outcome *(mRS 0-2, N = 110)*	*Unfavorable outcome (mRS 3-6, N = 84)*	*p*	*Survival (N = 189)*	*Death (N = 30)*	*p*	*No sICH (N = 198)*	*sICH (N = 13)*	*p*
Complications, *N*(%)	15 (13)	11 (10)	0.63	22 (12)	4 (13)	0.9	23 (12)	3 (23)	0.2
24h-NIHSS, median (IQR)[b]	4 (2-7)	16 (9.5-20)	<0.001	7 (2-14)	20 (16.75-24.25)	<0.001	7 (3-16)	20 (22-26)	<0.001
24h-ASPECTS, median (IQR)[b]	8 (7-9)	6 (5-8)	<0.001	8 (7-9)	5 (3-6)	<0.001	7 (5-9)	5 (3-6)	<0.001
sICH[a], *N*(%)	0	8 (10)	<0.001	8 (4)	5 (17)	0.03	-	-	-
Stroke recurrence[b], *N*(%)	3 (3)	8 (10)	0.06	5 (3)	6 (21)	0.001	11 (6)	0	0.001

BGC: balloon guiding catheter; ICA: internal carotid artery; IQR: interquartile range; IVT: intravenous thrombolysis; MCA: middle cerebral artery; mRS: modified Rankin Scale; SD: standard deviation; sICH: symptomatic intracerebral hemorrhage; ASPECTS: DWI-Alberta stroke program early CT score; mTICI: modified treatment in cerebral infarction.

[a]Data available for 211/219 patients.

[b]Data available for 204/219 patients.

Table 3. Multivariate analysis for primary and secondary endpoints.

	P value	OR [IC 95%]
Primary endpoint–Unfavorable outcome in overall population		
Age	0.001	1,06 [1.03–1.09]
Baseline NIHSS	<0.001	1.15 [1.08–1.22]
Secondary transfers	0.005	2.91 [1.39–6.04]
IVT	0.019	0.42 [0.20–0.87]
Number of passes	0.021	1.29 [1.04–1.61]
Adjusted for: Age, side, baseline ASPECTS, baseline mRS, baseline NIHSS, occlusion site, anesthesia protocol, OTR, procedure time (Groin-to-recanalization), IV thrombolysis, final mTICI, number of passes, complications, secondary transfers, use of BGC.		
Secondary endpoints		
Unfavorable outcome in adequately recanalised patients (mTICI 2b-3)		
Age	0.002	1.05 [1.03–1.08]
Baseline NIHSS	<0.001	1.15 [1.07–1.22]
Secondary transfers	0.005	2.95 [1.38–6.33]
IVT	0.022	0.41 [0.19–0.88]
Adjusted for: Age, side, baseline ASPECTS, baseline mRS, baseline NIHSS, occlusion site, OTR, procedure time (groin-to-recanalization), IV thrombolysis, final mTICI, number of passes, complications, secondary transfers, use of BGC		
Mortality		
Baseline mRS	0.003	
1 vs 0	0.534	1.57 [0.38–6.47]
2 vs 0	<0.001	10.67 [2.78–41.02]
Baseline NIHSS	0.003	1.17 [1.05–1.27]
Final mTICI 2b-3	0.012	0.18 [0.05–0.69]
Adjusted for: Age, side, baseline ASPECTS, baseline mRS, baseline NIHSS, occlusion site, anesthesia protocol, OTR, procedure time (groin-to-recanalization), IV thrombolysis, final mTICI, number of passes, complications, secondary transfers, use of BGC		
sICH		
Age	0.039	1.08 [1.07–1.29]
Baseline ASPECTS	0.005	0.53 [3.87–106.34]
First pass effect	0.033	0.10 [0.01–0.83]
Adjusted for: Age, side, baseline ASPECTS, baseline mRS, baseline NIHSS, occlusion site, anesthesia protocol, OTR, procedure time (groin-to-recanalization), IV thrombolysis, final mTICI, first pass effect, number of passes, complications, secondary transfers, use of BGC		

Discussion

- Patients with good collaterals could be described as the best candidates for mechanical thrombectomy.
- However, a non-negligible part of patients treated by MT does not reach functional independence after the endovascular treatment.
- This paper analyzed the impact of other factors that could explain the unfavorable clinical results in this specific subgroup of patients with good collaterals.

Collaterals and recanalization

- Although, adequate recanalization is widely known as an independent predictor of favorable clinical outcome, about half of the patients with adequate-to-complete recanalization do not achieve a functional independence.
- When we compared patients for outcomes, independent of the endovascular technique used, the rates of mTICI 2b-3 were significantly lower in the subgroup of patients with an unfavorable outcome.
- Interestingly, neither the FPE nor the mTICI grade resulted as independent predictor of favorable outcome or a protective factor for mortality at the multivariate analysis.
- These results are in line with the physio-pathological concept that collaterals supply the microcirculation in the ischemic territory during the arterial occlusion, maintaining a sort of “hemodynamic reserve”.

Collaterals and recanalization

- Other possible explanations of the effectiveness of the association between collaterals and recanalization could be related to the mitigation of the ischemic vascular injury or the better exposition to thrombolytics agents or to the higher chance of dislodgment of the clot.
- Nevertheless, complete recanalizations may have a favorable impact on the collateral circulation itself, allowing the removal of the thrombotic material in the pial arterioles and in the capillary bed providing a proper supply of the microcirculation.

Collaterals and time

- In this cohort, patients with unfavorable clinical outcomes were recanalized later with almost a 30-minutes difference in terms of onset-to-reperfusion.
- Secondary transfer was significantly associated with unfavorable outcomes. The most significant difference was observed in terms of procedure time, which was longer in patients with unfavorable outcomes.
- These results suggest that despite good collaterals, a fast and complete recanalization must remain the goal of mechanical thrombectomy. Therefore, good collaterals should not be considered as a “time machine” that would provide a certain tolérance for long procédures.

Collaterals and time

- Moreover, in our population we did not observe any significant difference in terms of clinical outcome between patients treated before and beyond 6 hours.
- Although higher recanalization grades were obtained before 6 hours, which supports the hypothesis of a neuroprotective effect of good collaterals on the brain tissue in both early and late windows.

Collaterals and thrombolysis

- The role of intravenous thrombolysis on collateral circulation still remains debated.
- Some Authors did not find any correlation between IVT and collaterals, while the other papers had underlined the role of both fibrin and platelets in the development of the in situ thrombotic phenomena that can occur within the collateral vessels, particularly in the venous side.
- IVT (mainly Alteplase according to the inclusion period) was significantly associated with favorable clinical outcomes with a protective effect observed at the multivariate analysis.

Collaterals and hemorrhagic transformation

- The rate of sICH was low as one could expect in a selected population with good collateral scores.
- In this cohort, older age and lower baseline ASPECTS were independent predictors of sICH, whereas partial or unsuccessful recanalizations (mTICI 0-2a) and longer procedures were associated with a higher rate of sICH.
- Furthermore, FPE had a protective effect on sICH at the multivariate analysis.

Strength and Limitations

- The retrospective nature of the analysis represents the main limitation of this study.
- Although the predictors of unfavorable outcome did not differ from those observed in overall stroke populations, this study represents, to the best of our knowledge, the first analysis specifically focused of this subgroup of patients, providing findings that could be potentially hypothesis-generating.
- Indeed, these results could be conditioned by the limited value of the ASITN/SIR in assessing the effectiveness of the collateral circulation despite its extension.

Conclusions

- Unfavorable clinical outcomes were observed in nearly half of patients following mechanical thrombectomy despite good collaterals according to the ASITN/SIR classification.
- Although a good collateral circulation could allow to achieve functional independency also in patients treated in late temporal windows, partial recanalizations and secondary transfers were associated with poor outcomes.

Conclusions

- FPE significantly correlated with the mortality but not with functional independence. Therefore, a complete and fast recanalization remains the goal also in this subgroup of patients.
- Intravenous thrombolysis increases the chance to achieve a good clinical outcome in patients with good collaterals without increasing the risk of hemorrhagic transformation.
- Furthermore, a thoughtful reflection about the angiographic tools and scales to assess collaterals should be encouraged.

Abstract

Background: Patients with acute ischemic stroke secondary to large vessel occlusions and good collaterals are frequently associated with favorable outcomes after mechanical thrombectomy (MT), although poor outcomes are observed also in this subgroup. We aimed to investigate the factors associated with unfavorable outcomes (mRS3-6) in this specific subgroup of patients.

Methods: 219 patients (117 females) with anterior circulation stroke and good collaterals (ASITN/SIR grades 3-4), treated by MT between 2016-2021 at our institution were included in this study. Clinical files and neuroimaging were retrospectively reviewed. Univariate and multivariate analyses were performed to identify the predictors of unfavorable outcomes in the overall population (primary endpoint). Secondary endpoint focused on the analysis of the predictors of unfavorable outcomes in the subgroup of successfully recanalized patients and mortality and symptomatic intracerebral hemorrhages (sICH) in the overall population.

Abstract

Results: Poor outcome was observed in 47% of the patients despite the presence of good collaterals. Older age (p<0.001), higher baseline NIHSS (p<0.001), no intravenous thrombolysis administration (no-IVT, p=0.004), >3 passes (p=0.01), and secondary transfers (p<0.001) were associated with the primary endpoint. The multivariate analysis showed a predictive effect of mTICI 2b-3 and of First Pass Effect (FPE) on sICH.

Conclusions: Despite good collaterals, defined through the ASITN/SIR scale, poor outcomes occurred in almost half of the patients. Patients with good collaterals not receiving IVT were significantly associated with unfavorable outcomes, whereas FPE was not significantly correlated with clinical outcome in this specific cohort of patients. Different methods to asses collaterals should also be investigated.

Thank You All