Acute Treatment of Isolated Posterior Cerebral Artery Occlusion: Single Center Experience

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Background and objectives: Randomized trials for mechanical thrombectomy (MT) excluded patients with ischemic strokes due to isolated posterior cerebral artery occlusion (IPCAO), and there is no evidence for best acute treatment strategy in these patients. We aimed to assess the effectiveness and safety of MT in acute IPCAO. *Methods:* We retrospectively analyzed consecutive patients with acute stroke due to IPCAO submitted to MT and/or intravenous thrombolysis (IVT), between 2015-2019. Effectiveness outcomes (recanalization rate, first-pass effect, NIHSS 24h improvement and 3-month Modified Ranking Scale - mRS) and safety outcomes (complications, symptomatic intracranial hemorrhage (SICH) and 3-month mortality) were described and compared between groups. *Results:* A total of 38 patients were included, 25 underwent MT and 13 had IVT alone. Successful and complete recanalization were achieved in 68% and 52% of MT patients, respectively. NIHSS improvement at 24h was found in 56% of MT patients versus 30.8% of patients submitted to IVT alone (OR [95% CI]=2.86 [0.69-11.82]) and excellent functional outcome at 3 months (mRS≤1) was achieved in 54.2% of MT patients versus 38.5% in the IVT group (OR [95% CI]=1.60 [0.41-6.32]). Complications occurred in 3 (12%) procedures and there were no SICH. Mortality at 3 months was 20% in the MT group and 15.4% in patients submitted to IVT alone. *Conclusions:* Our results reflect a real-world scenario in a single center and seem to support the recently growing literature showing that MT is a feasible and safe treatment in IPCAO, with favorable effectiveness.

Key Words: Stroke—Ischemic stroke—Acute stroke therapy—Posterior cerebral artery—Mechanical thrombectomy—Intervention—Intravenous thrombolysis

Introduction

Ischemic strokes in the posterior cerebral artery (PCA) territory represent up to 10% of all ischemic strokes.[1] Even though they are considered less disabling, they can have devastating consequences on functional independence and quality of life.[2] In addition to sensory, motor and balance deficits, visual field defect, particularly homonymous hemianopsia, is frequently present in isolated PCA occlusions (IPCAO).[2,3] Visual cognitive impairments (such as optic apraxia/ataxia, achromatopsia and prosopagnosia), neuropsychological manifestations and different forms of aphasia, including thalamic aphasia and amnesic aphasia, have been described in PCA strokes.[4]

According to the latest guidelines,[5] stroke patients with PCA occlusions should receive intravenous thrombolysis (IVT) within 4.5 hours from symptom onset. Mechanical

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thrombectomy (MT) with stent retrievers might be reasonable, if initiated within 6 hours from symptom onset (class IIb level of evidence).

Since large randomized trials for MT excluded these patients, evidence for MT in IPCAO is missing, with data available only from retrospective studies and case reports.[6–11] Endovascular treatment of a smaller and more distal artery such as the PCA is technically challenging, requiring appropriate devices and expertise.

In this retrospective study, we aimed to review our experience in acute stroke due to IPCAO, analyzing the effectiveness and safety of MT.

Methods

This study was approved by the Ethics Committee of Centro Hospitalar Universitário de Lisboa Central (process number 1014/2021). Requirement for patient informed consent was waived because of the retrospective nature of the study.

Patient selection

We included all consecutive patients with acute stroke due to IPCAO eligible to MT at baseline and submitted to MT and/or to IVT in the acute phase, between January 2015 and December 2019, at our stroke unit. IPCAO was defined as complete occlusion of the P1 to P3 segment of the PCA,[12] in the absence of concurrent occlusion of other intracranial arteries. MT eligibility complied with the following criteria: PCA occlusion accessible to MT (P1 to proximal P3 segments), and presence of clinical-imaging mismatch.

Data collection

Admission imaging studies included non-contrast brain computed tomography (CT) and cervical and cerebral single-phase CT angiography. Follow-up imaging with non-contrast CT or magnetic resonance imaging (MRI) at 24 hours was routinely performed.

Demographic and clinical data was obtained from a prospectively collected stroke database. According to our institutional protocol, all patients were examined at admission by a stroke physician. Stroke severity was assessed using the National Institutes of Health Stroke Scale (NIHSS). In Lisbon, endovascular treatment of stroke is organized in a 4-center rotation, and different centers are on call on a 1 in 4-week rotation. Treatment strategy was decided by the stroke physician and interventional neuroradiology team. IVT and MT was pursued in all patients. For outcome analysis, patients were divided into two groups: those that underwent MT (with IVT if admission up to 4.5h after symptoms and no contraindications), and those that underwent IVT alone (alteplase 0.9mg/Kg), either because there was immediate pos-IVT neurological improvement or PCA recanalization (6 patients), or because the patient was refused MT in one of the other endovascular centers on call (7 patients).

Outcome assessment

Effectiveness outcomes were recanalization rate, first-pass effect (FPE), NIHSS improvement at 24h and 3-month functional outcome. Recanalization rate was assessed according to the modified Treatment in Cerebral Infarction (mTICI) scale.[13] Grades 2B, 2C and 3 were considered "successful recanalization", and grades 2C and 3 were considered "complete recanalization". Recanalization status was not routinely assessed in patients submitted to IVT alone. FPE was defined as achievement of mTICI grade 2C or 3 after first pass. NIHSS improvement at 24h was defined as a minimum four-point score improvement compared to admission NIHSS. 3-month functional outcome was determined using the modified Rankin Scale (mRS)[14] at an outpatient consultation. Favorable functional outcome was defined as a maximum of one-point increase in the 3-month mRS as compared to the patient's pre-stroke mRS (3-month mRS of 0 or 1 for patients without pre-stroke disability and $\leq$1 increase in the 3-month mRS in patients with previous disability), as previously defined by Strambo and colleagues.[6] Excellent functional outcome was defined as 3-month mRS of 0 or 1.

Safety outcomes comprised procedure complications rate, the occurrence of symptomatic intracranial hemorrhage (SICH), as defined by the European Cooperative Acute Stroke Study (ECASS) II criteria,[15] and mortality at 3 months.

Statistical analysis

Categorical data were presented as frequencies (percentages), and quantitative variables as mean (SD: standard deviation), or median and inter-quartile range (IQR: 25th percentile-75th percentile), as appropriate. Demographics, baseline clinical and radiological characteristics and outcome measures of the two treatment groups were compared using Chi-Square tests for categorical variables and Mann-Whitney tests for quantitative variables. Considering the effectiveness outcomes of the study, odds ratios were estimated with corresponding 95% confidence intervals.

A level of significance α=0.05 was considered. Data were analyzed using the Statistical Package for the Social Science for Windows, version 25.0 (IBM Corp. Released 2017. IBM SPSS Statistics for Windows, Version 25.0. Armonk, NY: IBM Corp.).

Results

A total of 38 patients with acute stroke due to IPCAO were submitted to acute treatment: 25 patients were submitted to MT (14 with combined IVT and 11 with MT alone) and 13 patients were submitted to IVT alone.

Table 1. *MT and IVT groups: demographic and baseline characteristics.*

	MT group (n=25)	IVT group (n=13)	p-value
Female sex, n (%)	9 (36.0)	6 (46.2)	0.544
Age, median (P_{25}-P_{75}) (years)	80.2 (73.8-83.4)	74.9 (68.9-82.5)	0.234
NIHSS at admission, median (P_{25}-P_{75})	10 (6.0-14.5)	8 (5.5-10.0)	0.272
Baseline mRS, n (%)			0.052*
0	22 (88.0)	10 (76.9)	
2	0	1 (7.7)	
3	3 (12.0)	0	
4	0	2 (15.4)	
Clinical risk factors, n (%)			
Arterial hypertension	21 (84.0)	12 (92.3)	0.643*
Diabetes mellitus	8 (32.0)	5 (38.5)	0.730*
Dyslipidemia	8 (32.0)	7 (53.8)	0.191
Active smoker	4 (16.0)	1 (7.7)	0.643*
Previous smoker	1/21 (4.8)	1/12 (8.3)	1.000*
Previous stroke (> 3 months)	3 (12.0)	2 (15.4)	1.000*
Previous stroke (< 3 months)	0	0	-
Previous TIA	1 (4.0)	0	1.000*
Atrial fibrillation	10 (40.0)	5 (38.5)	0.927
Congestive heart failure	7 (28.0)	1 (7.7)	0.222*
TOAST classification, n (%)			0.735*
Cardioembolism	11 (44.0)	5 (38.5)	
Large-artery atherosclerosis	3 (12.0)	3 (23.1)	
Unknown	11 (44.0)	5 (38.5)	
Occlusion site, n (%)			0.607*
P1	14 (56.0)	5 (38.5)	
P2	9 (36.0)	7 (53.8)	
P3	2 (8.0)	1 (7.7)	
Occlusion Side, n (%)			0.927
Right	15 (60.0)	8 (61.5)	
Left	10 (40.0)	5 (38.5)	
fPCA, n (%)	0	1 (7.7)	0.342*
Treatment delay, median (P_{25}-P_{75}) (min)			
Onset-to-door	67 (54.8-104.8) [a]	107 (72.5-157.5)	0.031
Door-to-IVT	40 (27.8-79.0) [b,c]	30 (21.0-53.5)	0.205
Onset-to-IVT	131 (101.0-184.5) [b,d]	138 (112.5-211)	0.687
Onset-to-groin	224 (193.0-269.0) [e]	NA	

*Fisher's exact test, remaining p-values were obtained by Chi-square or Mann-Whitney tests, as appropriate. [a] Onset time is unknown in 3 patients and arrival time at the hospital was not registered in 4 patients. [b] Calculated for 14 patients who received combined IV tPA. [c] Arrival time was not registered in 2 patients who received combined IV tPA. [d] Onset time is unknown in 1 patient who received combined IV tPA. [e] Onset time is unknown in 3 patients and groin puncture time was not registered in 1 patient.

fPCA, fetal-type posterior cerebral artery; IVT, intravenous thrombolysis; MT, mechanical thrombectomy; mRS, modified Rankin Scale; NA, not applicable; NIHSS, National Institutes of Health Stroke Scale; TIA, transient ischemic attack; TOAST, Trial of Org 10172 in Acute Stroke Treatment.

Demographic and baseline characteristics were similar in both treatment groups as shown in Table 1.

In MT group, median age was 80 years (IQR 73.8-83.4) and 36% were female. Median NIHSS score at admission was 10 (IQR 6.0-14.5). Occlusion site was located at P1 segment in 14 (56%) cases, P2 segment in 9 (36%) cases and P3 segment in 2 (8%) cases. Combined IV tPA (alteplase 0.9mg/Kg) was administered in 14 (56%) patients. Endovascular treatment was performed with Direct Aspiration First Pass Technique (ADAPT) in 16 (64%) patients and stent retriever alone in two patients. Combined techniques were performed in four patients: aspiration and stent retriever in two patients and aspiration and intra-arterial thrombolysis (IAT) in two patients.

Onset-to-door time was significatively shorter in MT group (p=0.031). While the P2 segment represented the most common site of occlusion in IVT group (53,8%), this difference between groups did not reach statistical significance.

Outcome results are summarized in Table 2. Regarding MT group, successful recanalization was achieved in 17 (68%) patients and complete recanalization in 13 (52%). FPE was achieved in 7/23 patients (number of passes was not registered in two patients), and overall median

Table 2. *MT and IVT groups: effectiveness and safety outcomes.*

	MT group (n=25)	IVT group (n=13)	Unadjusted OR* (95% CI)
Effectiveness outcomes			
Recanalization, n (%)		NAV	
Successful recanalization (mTICI 2b-3)	17 (68.0)		
Complete recanalization (mTICI 2c-3)	13 (52.0)		
FPE	7 (30.4) [a]		
NIHSS improvement at 24h, n (%)	14 (56.0)	4 (30.8)	2.86 (0.69-11.82)
3-month functional outcome (3-month mRS), n (%)			
Favorable (≤1 increase to baseline mRS)	13 (54.2) [b]	6 (46.2)	1.38 (0.36-5.34)
Excellent (3-month mRS 0-1)	12 (50.0) [b]	5 (38.5)	1.60 (0.41-6.32)
Functional independence (3-month mRS 0-2)	12 (50.0) [b]	8 (61.5)	0.63 (0.16-2.47)
Safety outcomes, n (%)			
Intra-procedure complication	3 (12.0)	NA	
SICH	0	0	
3-month mortality	5 (20.0)	2 (15.4)	1.38 (0.23-8.30)

[a] Number of passes was not registered in 2 patients. [b] 3-month mRS value not available in 1 patient. *Reference category: IVT group.

CI, confidence interval; IVT, intravenous thrombolysis; MT, mechanical thrombectomy; mRS, modified Rankin Scale; mTICI, modified Treatment in Cerebral Infarction score; NA, not applicable; NAV, not available; NIHSS, National Institutes of Health Stroke Scale; OR, odds ratio estimate; SICH, symptomatic intracranial hemorrhage.

number of passes was 1 (range 1-4). Median groin-to-recanalization time was 35 minutes (IQR 22-67) and median total procedure time was 65 minutes (IQR 28.8-79.8). Median onset-to-recanalization time was 285 minutes (IQR 243.0-339.5). NIHSS improvement at 24h was achieved in 56% of patients. Thirteen out of 24 patients (54.2%) had a favorable 3-month functional outcome (not available in one patient).

Regarding patients submitted to IVT alone, 4 patients (30.8%) achieved NIHSS improvement at 24h and 6 (46.2%) had a favorable 3-month functional outcome.

MT procedure complications rate was 12% (n=3), however only 2 (8%) patients had clinical consequences. Migration of thrombus to the contralateral PCA occurred in two procedures (Figure 1). The third complication was dissection and occlusion of the left vertebral artery in a patient with a right P3 occlusion, in the presence of a hypoplastic right vertebral artery (final mTICI grade 0).

The 3-month mortality rate in MT group was 20% (n=5). Two patients died from extensive ischemic lesions after unsuccessful recanalization, and 3 patients died due to nosocomial respiratory infections. The 3-month mortality rate in IVT group was 15.4% (n=2). One patient died due to nosocomial respiratory infection. The other patient developed a urinary infection and progressive neurologic deterioration, and died on day 26 post-stroke. No patient of either group suffered SICH.

Median NIHSS at 24h was 4.5 (IQR 2.0-11.5) and of 5.0 (IQR 3.0-11.0) in MT and IVT groups, respectively (p=0.766). A non-significant NIHSS improvement at 24h was registered in 56% of patients in MT group versus 30.8% in IVT group (OR [95% CI]=2.86 [0.69-11.82]). An excellent outcome at 3 months was found in 50% of MT patients versus 38.5% of IVT patients (OR [95% CI]=1.60 [0.41-6.32]) while functional independence at 3 months was achieved in 50% of MT patients versus 61.5% of IVT patients (OR [95% CI]=0.63 [0.16-2.47]). In both groups, there was a similar proportion of patients with baseline mRS >2 (12% in MT group, and 15.4% in IVT group).

In patients submitted to MT, odds ratios estimation showed that NIHSS improvement at 24h (OR [95% CI] =24.75 [2.89-212.23], p=0.003), successful recanalization (OR [95% CI]=14.40 [1.36-152.53], p=0.027) and complete recanalization (OR [95% CI]=8.89 [1.40-56.58], p=0.021) were associated to favorable functional outcome. However, a multivariable model was not achieved for any outcome.

Discussion

Our results support that MT represents a valid treatment option in IPCAO patients, with favorable effectiveness and reasonable safety. Successful recanalization (mTICI 2b-3) rate was 68%, with a FPE of 30.4%. As is known for anterior circulation stroke, successful recanalization was associated with favorable functional outcome.[16]

Advances in neuroendovascular devices have allowed targeting smaller vessels such as PCA for mechanical thrombectomy, with increasing rates of success and safety, and improved standard of care in stroke patients.[17,18]

Randomized controlled trials have established the benefits of mechanical thrombectomy in acute ischemic stroke due to large vessel occlusion in the anterior circulation,[19] however information regarding efficacy and safety of MT in IPCAO is still based on a few retrospective series and case reports. Previous studies have analyzed IVT and MT in the posterior circulation in comparison to the anterior circulation, with similar efficacy and safety results.[20,21] However, IPCAO represented a very low percentage of cases in these studies. One study focused on intra-arterial thrombolysis in IPCAO, with favorable functional clinical

Fig. 1. ***Migration of thrombus to contralateral PCA.*** ***(A)*** *Patient with left P2 occlusion submitted to MT with ADAPT technique and combined IV tPA.* ***(B)*** *Clot migration to the contralateral P1 segment.* ***(C)*** *Successful recanalization, with a final mTICI grade 3 bilaterally.* ***(D)*** *Patient with a left P1 occlusion submitted to aspiration and stent retriever combined technique, with no combined IV tPA.* ***(E)*** *Clot migration to the contralateral P1 segment.* ***(F)*** *Recanalization attempt was unsuccessful, with a final mTICI grade 0 bilaterally.*

outcomes and absence of major complications.[22] More recently, a few retrospective case series have demonstrated the treatment benefit and safety of MT in IPCAO.[6–11]

While our results are generally in line with previously published series, they differ mainly in the inclusion of P2 and P3 occlusions, and in the MT approach used. Previous studies[7,8] included a higher percentage of proximal occlusions (P1 in 80% and 77.3% of cases, respectively, *versus* 56% in our series). Recently, two multicenter retrospective studies focused on acute revascularization of P2 and P3 occlusions with promising results.[10,11] Stent retrievers were the most used technique in these studies. At our institution, aspiration-based techniques are first-intention in MT. In fact, stent retrievers alone were used in just 2/25 cases in our series. Importantly, in 5/7 cases where FPE was achieved, the ADAPT technique was performed. Our experience further supports the feasibility of aspiration technique in IPCAO, including in distal (P2 and P3) occlusions (Figure 2). Additionally, all procedures were performed under conscious sedation, as opposed to other series, that use general anesthesia in 43 to 94 % of cases.[7,10,11]

In this retrospective study, in a small cohort of patients with IPCAO, a non-significant difference regarding

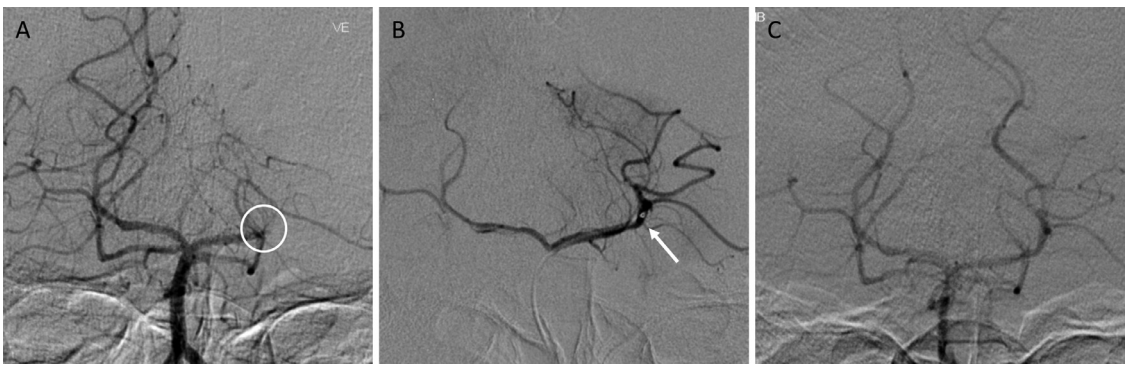

Fig. 2. ***Successful recanalization of a distal occlusion performing a direct aspiration technique.*** ***(A)*** *Patient with left P2 occlusion submitted to ADAPT technique MT and combined IV tPA.* ***(B)*** *Aspiration catheter (3French) positioned in the P2 segment during second pass aspiration.* ***(C)*** *Successful recanalization, with a final mTICI grade 3.*

clinical improvement at 24h post-treatment and functional outcome at 3 months was found between patients undergoing MT and patients submitted to IVT alone. This is in line with other available studies.[6,11]

A similar safety profile was found for both treatment strategies. Complications occurred on 3 MT procedures: contralateral thrombus migration in 2 cases, and arterial dissection in one case. This is in line with other studies,[6–11] and emphasizes the importance of performing MT in small caliber vessels in high-volume and experienced stroke centers. Mortality at 3 months was also in line with previous studies (ranging from 6.7% to 22.9%).[6–8,10,11] Mortality at 3 months in the MT group in our series parallels mortality rates for MT in the anterior circulation in large series.[23] The absence of SICH in both groups further supports that MT can be safely performed in IPCAO patients.

Our study has limitations, the most important of which are the small size of our cohort and its retrospective design. Since MT was pursued for all patients at baseline, this may lead to a selection bias. In fact, onset-to-door time was significatively shorter in the MT group, which could have possibly influenced the results towards better outcome in MT patients. We did not perform neurocognitive/neuropsychological and visual evaluation at follow-up. Recanalization was not assessed in the IVT group, and therefore was not compared between groups.

This study reflects a real-world scenario, in which patients with P1 to P3 occlusions were included whenever considered accessible for endovascular treatment, and where aspiration is the first-intention technique used for MT. These are differences that might add to the literature on the reported experience in treatment of IPCAO.

In conclusion, our results support the existing literature on MT as a feasible and safe treatment for IPCAO, with favorable immediate clinical improvement and long-term functional outcome. Aspiration techniques might be effective in IPCAO and more distal occlusions of the PCA might be accessible to treatment, but this remains to be investigated in larger studies.

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Data sharing statement

For any questions or further data requests, contact first author.

Declaration of Competing Interest

The Authors declare that there is no conflict of interest.

References

1. Cereda C, Carrera E. Posterior cerebral artery territory infarctions. Front Neurol Neurosci 2012;30:128-131. https://doi.org/10.1159/0003336104.
2. Ng YS, Stein J, Salles SS, Black-Schaffer RM. Clinical characteristics and rehabilitation outcomes of patients with posterior cerebral artery stroke. Arch Phys Med Rehabil 2005;86:2138-2143. https://doi.org/10.1016/j.apmr.2005.07.289.
3. Finelli PF. Neuroimaging in acute posterior cerebral artery infarction. Neurologist 2008;14:170-180. https://doi.org/10.1097/NRL.0b013e3181627679.
4. Servan J, Verstichel P, Catala M, Yakovleff A, Rancurel G. Aphasia and infarction of the posterior cerebral artery territory. J Neurol 1995;242:87-92. https://doi.org/10.1007/BF00887822.
5. Powers WJ, Rabinstein AA, Ackerson T, Adeoye OM, Bambakidis NC, Becker K, et al. Guidelines for the early management of patients with acute ischemic stroke: 2019 update to the 2018 guidelines for the early management of acute ischemic stroke a guideline for healthcare professionals from the. American Heart Association/American Stroke A 2019;50. https://doi.org/10.1161/STR.0000000000000211.
6. Strambo D, Bartolini B, Beaud V, Marto JP, Sirimarco G, Dunet V, et al. Thrombectomy and Thrombolysis of Isolated Posterior Cerebral Artery Occlusion: Cognitive, Visual, and Disability Outcomes. Stroke 2020;51:254-261. https://doi.org/10.1161/STROKEAHA.119.026907.
7. Clarençon F, Baronnet F, Shotar E, Degos V, Rolla-Bigliani C, Bartolini B, et al. Should posterior cerebral artery occlusions be recanalized? Insights from the Trevo Registry. Eur J Neurol 2020;27:787-792. https://doi.org/10.1111/ene.14154.
8. Memon MZ, Kushnirsky M, Brunet MC, Saini V, Koch S, Yavagal DR. Mechanical thrombectomy in isolated large vessel posterior cerebral artery occlusions. Neuroradiology 2020. https://doi.org/10.1007/s00234-020-02505-w.
9. Meyer L, Papanagiotou P, Politi M, Kastrup A, Kraemer C, Hanning U, et al. Feasibility and safety of thrombectomy for isolated occlusions of the posterior cerebral artery: a multicenter experience and systematic literature review. J Neurointerv Surg 2020. neurintsurg-2020-016059https://doi.org/10.1136/neurintsurg-2020-016059.
10. Miszczuk M, Bauknecht HC, Kleine JF, Kabbasch C, Liebig T, Bohner G, et al. Mechanical thrombectomy of acute distal posterior cerebral artery occlusions. J Clin Neurosci 2021;88:57-62. https://doi.org/10.1016/j.jocn.2021.03.027.
11. Meyer L, Stracke CP, Jungi N, Wallocha M, Broocks G, Sporns PB, et al. Thrombectomy for Primary Distal Posterior Cerebral Artery Occlusion Stroke: The TOPMOST Study. JAMA Neurol 2021;78:434-444. https://doi.org/10.1001/jamaneurol.2021.0001.
12. Yaşargil G. Microneurosurgery, Volume II. Stuttgard: George Thieme Verlag; 1984.
13. Zaidat OO, Yoo AJ, Khatri P, Tomsick TA, Von Kummer R, Saver JL, et al. Recommendations on angiographic revascularization grading standards for acute ischemic stroke: A consensus statement. Stroke 2013;44:2650-2663. https://doi.org/10.1161/STROKEAHA.113.001972.
14. Van Swieten JC, Koudstaal PJ, Visser MC, Schouten H, Van Gijn J. Interobserver agreement for the assessment of handicap in stroke patients. Stroke 1988;19:604-607. https://doi.org/10.1161/01.STR.19.5.604.

15. Hacke W, Kaste M, Fieschi C, Von Kummer R, Davalos A, Meier D, et al. Randomised double-blind placebo-controlled trial of thrombolytic therapy with intravenous alteplase in acute ischaemic stroke (ECASS II). Lancet 1998;352:1245-1251. https://doi.org/10.1016/S0140-6736(98)08020-9.
16. Goyal M, Menon BK, Van Zwam WH, Dippel DWJ, Mitchell PJ, Demchuk AM, et al. Endovascular thrombectomy after large-vessel ischaemic stroke: A meta-analysis of individual patient data from five randomised trials. Lancet 2016;387:1723-1731. https://doi.org/10.1016/S0140-6736(16)00163-X.
17. Saver JL, Chapot R, Agid R, Hassan A, Jadhav AP, Liebeskind DS, et al. Thrombectomy for Distal, Medium Vessel Occlusions: A Consensus Statement on Present Knowledge and Promising Directions. Stroke 2020:2872-2884. https://doi.org/10.1161/STROKEAHA.120.028956.
18. Sweid A, Head J, Tjoumakaris S, Xu V, Shivashankar K, Alexander TD, et al. Mechanical Thrombectomy in Distal Vessels: Revascularization Rates, Complications, and Functional Outcome. World Neurosurg 2019;130:e1098-e1104. https://doi.org/10.1016/j.wneu.2019.07.098.
19. Saver JL, Goyal M, Van Der Lugt A, Menon BK, Majoie CBLM, Dippel DW, et al. Time to treatment with endovascular thrombectomy and outcomes from ischemic stroke: Ameta-analysis. JAMA - J Am Med Assoc 2016;316:1279-1288. https://doi.org/10.1001/jama.2016.13647.
20. Breuer L, Huttner HB, Jentsch K, Blinzler C, Winder K, Engelhorn T, et al. Intravenous thrombolysis in posterior cerebral artery infarctions. Cerebrovasc Dis 2011;31:448-454. https://doi.org/10.1159/000323253.
21. Weber R, Minnerup J, Nordmeyer H, Eyding J, Krogias C, Hadisurya J, et al. Thrombectomy in posterior circulation stroke: differences in procedures and outcome compared to anterior circulation stroke in the prospective multicentre REVASK registry. Eur J Neurol 2019;26:299-305. https://doi.org/10.1111/ene.13809.
22. Meier N, Fischer U, Schroth G, Findling O, Brekenfeld C, El-Koussy M, et al. Outcome after thrombolysis for acute isolated posterior cerebral artery occlusion. Cerebrovasc Dis 2011;32:79-88. https://doi.org/10.1159/000328229.
23. Meinel TR, Kaesmacher J, Mordasini P, Mosimann PJ, Jung S, Arnold M, et al. Outcome, efficacy and safety of endovascular thrombectomy in ischaemic stroke according to time to reperfusion: data from a multicentre registry. Ther Adv Neurol Disord 2019;12:175628641983570. https://doi.org/10.1177/1756286419835708.