Endovascular treatment vs drug therapy alone in patients with mild ischemic stroke and large infarct cores

Wen-Hui Kou, Xiao-Qin Wang, Jin-Shui Yang, Nan Qiao, Xiao-Hui Nie, Ai-Mei Yu, Ai-Xia Song, Qian Xue

BACKGROUND
Treatment decision making is strictly associated with the outcomes in patients with ischemic stroke who show a large core infarct. Medical care alone may result in suboptimal treatment efficacy, and endovascular treatment may be accompanied by safety issues. Whether endovascular treatment is superior to medical care is not well investigated in the clinical studies.

AIM
To investigate the efficacy of endovascular treatment and drug therapy alone in mild ischemic stroke patients with large infarct cores.

METHODS
Fifty patients with mild ischemic stroke and 50 patients with acute ischemic stroke caused by anterior large vessel occlusion were selected at the First Affiliated Hospital of Hebei North University between January 2021 and December 2021. Patients were divided into an endovascular therapy group and a drug therapy group according to different treatment methods. In the endovascular therapy group, there were 28 patients with minor stroke and 22 patients with large infarct cores. The drug therapy group had 22 patients with minor stroke and 28 patients with large infarct cores. The National Institutes of Health Stroke Scale (NIHSS) scores were collected and compared between the two groups immediately after the operation and 24 h and 7 d after the operation. The modified Rankin scale (mRS) and/or activity of daily living were assessed at hospital discharge.

RESULTS
There was no significant difference in NIHSS scores between the two groups before the operation ($P > 0.05$). NIHSS scores were lower in the endovascular therapy group than in the drug therapy group at 24 h and 7 d after the operation and at hospital discharge (all $P < 0.05$). The incidence of early neurologic deteri-
oration was significantly lower in the endovascular therapy group than in the drug therapy group ($P < 0.05$). At hospital discharge, the mRS score was lower in the endovascular treatment group than in the drug therapy group, and the activity of daily living score was better in the endovascular treatment group than in the drug therapy group (all $P < 0.05$). During a follow-up of 3 mo, 17 patients (34.0%) had good prognosis (mRS ≤ 2), 33 patients (66.0%) had poor prognosis (mRS > 2), and 11 patients (22.0%) died. In the medical treatment group, 16 patients (mRS ≤ 2) had good prognosis (32.0%), 34 patients (mRS > 2) had poor prognosis (68.0%), and 14 patients (28.0%) died. There was no significant difference in prognosis and mortality between the two groups ($P > 0.05$).

**CONCLUSION**

Endovascular therapy can improve NIHSS score and mRS score in patients with mild ischemic stroke and large infarct cores. It is suitable for clinical application.

**Key Words:** Ischemic stroke; Large infarct cores; Endovascular therapy; Drug therapy; Efficacy

©The Author(s) 2022. Published by Baishideng Publishing Group Inc. All rights reserved.

**Core Tip:** Fast and correct first aid can save lives and avoid disabilities in patients with acute ischemic stroke. The limited therapeutic time window and relative contraindications confine medical care for the treatment of acute ischemic stroke. Endovascular therapy ranks among the major therapies from an important alternative for medical therapy in the treatment of acute ischemic stroke. The present study compared the clinical efficacy and safety of these two treatment approaches in patients with acute ischemic stroke. It found that the two approaches achieved comparable results in favorable prognosis. However, endovascular therapy can effectively improve neurological function compared with medical therapy.

**INTRODUCTION**

A mild stroke is a sudden development of mild focal neurologic deficit caused by some type of vascular disorder. A mild stroke may last for just a few minutes or up to 24 h. The neurologic deficit is usually caused as a result of ischemic infarct on imaging tests, and it usually had clinical manifestations$[1-3]$. A mild stroke is usually defined as National Institute of Health Stroke Scale (NIHSS) score ≤ 5 or the modified Rankin scale (mRS) score ≤ 3$[4-6]$.

Recent evidence on whether endovascular therapy (EVT) should be recommended to patients with large artery occlusive disease are lacking. Moreover, there was substantial heterogeneity among studies of EVT in patients with mild stroke, and EVT is not well-studied in clinical research in China$[7-9]$. Although patients with acute ischemic stroke (AIS) caused by anterior large vessel occlusion (LVO) often prefer EVT, which can increase recanalization rates and improve the clinical outcomes$[10]$, controversy still remains regarding whether AIS-LVO patients need EVT$[11,12]$.

Previous studies believed that infarct core volume is closely associated with clinical outcomes$[13]$. Small core volume is associated with good clinical outcomes, although the favorable prognosis rate may be low in AIS-LVO patients with large infarct cores who received drug therapy alone$[14]$. The present study aimed to discuss the efficacy of EVT in patients with AIS-LVO and large infarct cores. The efficacy of EVT was compared with medical treatment between patients with mild ischemic stroke and patients with AIS-LVO to provide clinicians with clinical guidance on the selection of appropriate therapy.

**MATERIALS AND METHODS**

**Participants**

Fifty patients with mild ischemic stroke and 50 patients with large infarct cores were enrolled at the First Affiliated Hospital of Hebei North University between January 2021 and December 2021. Based on
different therapies they received, they were categorized into an EVT group and a drug therapy group. In the EVT group, 28 patients had mild stroke and 22 patients had large infarct cores including 31 males and 19 females aged 35 to 57 (51.23 ± 7.45) years. In the drug therapy group, 22 had mild stroke and 28 patients had large infarct cores including 30 males and 20 females aged 36 to 58 (53.17 ± 8.93) years. The general information was comparable between the two groups.

Diagnostic standard was NIHSS score ≤ 5 or mRS score ≤ 3 measured independently by two experienced clinical neurologists for mild stroke and infarct core volume ≥ 70 mL on computed tomography perfusion imaging for large infarct cores[15,16].

Inclusion criteria were adult patients (> 18 years) with acute anterior circulation ischemic stroke, which lasted < 8 h on diagnostic imaging involving internal carotid artery, M1 and M2 segments of middle cerebral artery, and anterior cerebral artery[17,18]. Patients and their family members were informed about the treatment and signed the informed consent form.

Patients who were confirmed with intracranial hemorrhage by computed tomography and magnetic resonance imaging, patients who were previously confirmed with arteriovenous malformation or arteriovenous aneurysm or space-occupying lesions on diagnostic imaging, and patients who were patients lost to follow-up were excluded from the study.

Methods
A random number table was used to assign these patients to an EVT group and a medical treatment group. They were followed up for 3 mo. In the EVT group, patients were operated under local anesthesia and intravenous anesthesia, and general anesthesia was performed if the patients were restless. Patients lied on their back, and 8F arterial sheaths were used for puncture of the right-sided femoral artery. Imaging examination was performed to identify occlusion sites. 8F MPA1 guiding catheter was placed into the distal carotid arteries. 5F-125 Naven intermediate conductor was delivered to the distal internal carotid arteries along the guiding catheter. A Rebar-18 microcatheter was introduced into the distal thrombus via an 0.014" guide wire. Microvascular imaging was performed to identify whether the distal occluded vessel was obstructed and where the specific occlusion sites were distributed[19,20]. Solitaire AB stent was placed thorough the microcatheter and held on for 5 min until a complete release of stent was observed. Then stents and microcatheters were withdrawn, and a 50 mL syringe was used to draw blood. Care should be taken when performing the operation to avoid shedding of the thrombus from the stents and at last leading to distal vascular occlusion. After thrombectomy, contrast examination was performed to investigate revascularization. If the thrombolysis in cerebral infarction scale score was < 2b, thrombectomy could be repeated 3 times until the thrombolysis in cerebral infarction scale score was ≥ 2b or equal to 3. For the medical treatment group, conventional agents for cerebral infarction were administrated including alteplase (Boehringer Ingelheim Pharma GmbH & Co. KG, S20160055) and tirofiban (Huadong Medicine, H20060265).

Assessment measures included: (1) NIHSS scores at different times points before the operation, at 24 h and 7 after the operation, and before the discharge; (2) Short-term prognosis within 48 h after the operation on computed tomography scan of the brain for hemorrhage and vascular condition and cranial magnetic resonance imaging for deterioration of neurological function such as vascular reocclusion, tissue edema, and hematencephalon[21]; and (3) Long-term recovery efficiency of modified mRS score and/or activity of daily living score.

Statistical analysis
SPSS 26.0 software was used for data analysis. Quantitative variables were reported with number and percentage, and qualitative variables were presented as mean ± SD, if it showed normal distribution. P < 0.05 represented there was a significant difference.

RESULTS
In terms of the NIHSS score, no significant difference was observed between the two groups before the operation (P > 0.05). At 24 h and 7 d after the operation and before hospital discharge, the NIHSS score was lower in the EVT group than in the medical treatment group (P < 0.05, Table 1).

After comparison of the incidence of short-term deterioration of neurological function, it was found that repeated occlusion occurred in 3 patients, tissue edema occurred in 1 patient, and no one had cerebral hemorrhage with the overall incidence of 8.0% in the EVT group. In the medical treatment group, recurrent occlusion occurred in 5 patients, tissue edema occurred in 3 patients, and cerebral hemorrhage in 1 patient with the overall incidence of 18.0%. The incidence of short-term deterioration of neurological function was lower in the EVT group than in the medical treatment group (P < 0.05, Table 2).

At discharge, the mRS score was lower in the EVT group than in the medical treatment group, and the activity of daily living score was better in the EVT group than in the medical treatment group. The differences between the two groups were significant (P < 0.05, Table 3).
Table 1 National Institutes of Health Stroke Scale score compared between the two at different time points (mean ± SD)

| Groups                        | n  | Before the operation | 24 h after the operation | 7 d after the operation | Before discharge |
|-------------------------------|----|----------------------|--------------------------|-------------------------|-----------------|
| Endovascular treatment group  | 50 | 16.43 ± 6.34         | 12.23 ± 5.63             | 10.35 ± 4.01            | 6.83 ± 1.23     |
| Medical treatment group       | 50 | 17.09 ± 5.98         | 14.11 ± 6.03             | 12.38 ± 5.22            | 8.23 ± 2.09     |

| t value                      | 1.023 | 4.522 | 7.093 | 13.12 |
| P value                      | 0.276 | 0.042 | 0.024 | 0.001 |

Table 2 Incidence of early deterioration of neurological function, n (%)

| Groups                        | n  | Repeated vascular occlusion | Tissue edema | Cerebral hemorrhage | Overall incidence |
|-------------------------------|----|----------------------------|--------------|---------------------|------------------|
| Endovascular treatment group  | 50 | 3 (6.0)                    | 1 (2.0)      | 0 (0.0)             | 4 (8.0)          |
| Medical treatment group       | 50 | 5 (10.0)                   | 3 (6.0)      | 1 (2.0)             | 9 (18.0)         |

| \( \chi^2 \) value | 9.234 |
| P value            | 0.001 |

Table 3 Comparison of the modified Rankin scale and activity of daily living scores between the two groups (mean ± SD)

| Groups                        | n  | mRS score            | ADL score          |
|-------------------------------|----|----------------------|--------------------|
| Endovascular treatment group  | 50 | 4.11 ± 0.24          | 59.93 ± 15.73      |
| Medical treatment group       | 50 | 5.09 ± 0.83          | 46.71 ± 16.22      |

| t value                      | 6.172 | 5.522 |
| P value                      | 0.031  | 0.035 |

mRS: Modified Rankin scale; ADL: Activity of daily living.

For the long-term treatment efficacy, 17 (34.0%) patients achieved good prognosis (mRS ≤ 2), 33 (66.0%) patients had poor prognosis (mRS > 2), and 11 patients (22.0%) died in the EVT group. In the medical treatment group, 16 (32.0%) achieved good prognosis (mRS ≤ 2), 34 (68.0%) patients had poor prognosis (mRS > 2), and 14 (28.0%) patients died. There was no significant difference in the good prognosis and mortality between the two groups (\( P < 0.05 \)).

**DISCUSSION**

The morbidity rate for AIS with mild symptoms is high. Mild ischemic stroke complicated with macrovascular diseases or stenosis and occlusion is not uncommon in the clinical practice. The risk for short-term neurological function is higher and the prognosis is poorer in these population than in patients without macrovascular diseases[22]. It has been proven that EVT can effectively help occluded vessels stay open. However, surgery-related hemorrhage, postoperative death, and incidence of complications are high, and it should not be ignored when surgical treatment is selected[23, 24]. In particular, there is no consistent conclusion on EVT performed in patients with AIS with mild symptoms complicated with macrovascular diseases, which makes clinical decision making more difficult[25, 26]. Chinese guidelines for treatment of AIS 2018 recommend that antiplatelet agents should be used in eligible patients after assessing benefits and risks within 24 h after intravenous thrombolysis using alteplase. The present study analyzed the treatment efficacy of EVT and medical treatment alone in patients with mild ischemic stroke and large infarct cores.

In clinical practice, some clinicians thought AIS with mild symptoms may lead to good outcomes, and they tended to use conservative treatment to prevent the possible risks and complications associated with intravenous thrombolysis and arterial thrombectomy. However, previous studies found that inpatient relapse was high in AIS with mild symptoms, which may be attributed to the elevated disability rate and mortality caused by the early neglect of active treatment[27-29].

Results of the study revealed that NIHSS scores were lower in the EVT group than in the medical treatment group. At discharge, the mRS score was lower in the EVT group than in the medical treatment group. Furthermore, activity of daily living score was better in the EVT group than in the medical
treatment group (all $P < 0.05$). This suggested that EVT showed obvious efficacy for the treatment of mild ischemic stroke and large infarct cores with improvements in neurological function.

Meanwhile, there was no significant difference in good prognosis and mortality between the two groups after a follow-up of 3 mo ($P > 0.05$). However, it is possible that the vascular condition was poor in the EVT group compared with the medical treatment group, which may cause selection bias. A sufficiently large sample size is necessary for further research to avoid bias and to reflect that patients with good vascular condition can achieve ideal treatment efficacy on medical treatment.

**CONCLUSION**

EVT is effective in the treatment of mild ischemic stroke and large infarct cores. It provides great benefits and promotes rehabilitation in this population.

**ARTICLE HIGHLIGHTS**

**Research background**

Endovascular therapy and medical therapy are two major approaches for the treatment of acute ischemic stroke with large vessel occlusion. Comparison of the clinical efficacy and safety of the two approaches is needed.

**Research motivation**

This study provided evidence for clinicians to better help them make an appropriate treatment decision in the treatment of acute ischemic stroke with large vessel occlusion.

**Research objectives**

This study aimed to compare the efficacy and safety of endovascular treatment with medical therapy alone in patients with acute ischemic stroke who show a large core infarct.

**Research methods**

Fifty patients with mild ischemic stroke and 50 patients with large core and occlusion ischemic stroke were enrolled in the study. They were categorized into an endovascular treatment group (28 patients with mild stroke and 22 patients with large infarct cores) and a medical treatment group (22 patients with mild stroke and 28 patients with large infarct cores). Patients in the endovascular treatment group underwent an interventional thrombectomy, and patients in the medical treatment group were treated with alteplase or tirofiban. The National Institutes of Health Stroke Scale scores and short- and long-term prognosis were analyzed in the two groups.

**Research results**

Significant differences were found in the National Institutes of Health Stroke Scale scores, early deterioration of neurological function, the modified Rankin scale, and the activity of daily living scores between the two groups. However, no significant difference was found in favorable prognosis and mortality between the two groups.

**Research conclusions**

Patients receiving endovascular treatment had a higher chance of achieving good neurological function compared with those receiving medical therapy.

**Research perspectives**

This study revealed that neurological function was effectively improved in patients with acute ischemic stroke after endovascular treatment. Endovascular technology evolves at a rapid pace. Future studies should take these new devices and techniques into consideration when investigating endovascular treatment in patients with acute ischemic stroke.

**FOOTNOTES**

Author contributions: Kou WH, Wang XQ, Yang JS, Qiao N, Nie XH, Yu AM, Song AX, and Xue Q designed the research study; Kou WH, Wang XQ, and Yang JS performed the research; and all authors have read and approved the final manuscript.

Supported by Scientific Research Fund of Hebei Health Commission 2022, No. 20220591.
**Institutional review board statement:** The study was reviewed and approved by the First Affiliated Hospital of Hebei North University Institutional Review Board.

**Informed consent statement:** All study participants, or their legal guardian, provided informed written consent prior to study enrollment.

**Conflict-of-interest statement:** The authors declare no conflict of interest.

**Data sharing statement:** No additional data are available.

**Open-Access:** This article is an open-access article that was selected by an in-house editor and fully peer-reviewed by external reviewers. It is distributed in accordance with the Creative Commons Attribution NonCommercial (CC BY-NC 4.0) license, which permits others to distribute, remix, adapt, build upon this work non-commercially, and license their derivative works on different terms, provided the original work is properly cited and the use is non-commercial. See: https://creativecommons.org/Licenses/by-nc/4.0/

**Country/Territory of origin:** China

**ORCID number:** Ai-Xia Song 0000-0003-3311-6061.

S-Editor: Wang JL
L-Editor: Filipodia
P-Editor: Wang JL

**REFERENCES**

1. **Stroke Prevention and Control Project Committee:** National Health Commission, Neurointerventional Group, Neurosurgery Branch, Chinese Medical Association; Interventional Group, Radiology Branch, Chinese Medical Association. [Chinese experts consensus on the treatment of acute ischemic stroke caused by anterior large vessel occlusion (2019 revision)]. Zhonghua Shenjing Waite Zazhi 2019; 35: 868-879 [DOI: 10.3760/cma.j.issn.1001-2346.2019.09.002]

2. **Zhu QF,** Su Q, Chen LZ. [Research progress of time window and tissue window on mechanical thrombectomy in acute ischemic stroke]. Zhongguo Zonghe Linchuang 2020; 36: 572-576 [DOI: 10.3760/cma.j.cn121361-20191023-00030]

3. **Stroke Prevention and Control Project Committee:** National Health Commission, Neurointerventional Group, Neurosurgery Branch, Chinese Medical Association; Interventional Group, Radiology Branch, Chinese Medical Association. [Chinese experts consensus on the treatment of acute ischemic stroke caused by anterior large vessel occlusion (2017)]. Zhonghua Shenjing Waite Zazhi 2017; 33: 869-877 [DOI: 10.3760/cma.j.issn.1001-2346.2017.09.002]

4. **Bouslama M,** Barreira CM, Haussen DC, Rodrigues GM, Pisani L, Frankel MR, Nogueira RG. Endovascular reperfusion outcomes in patients with a stroke and low ASPECTS is highly dependent on baseline infarct volumes. J Neurointerv Surg 2022; 14: 117-121 [PMID: 33722970 DOI: 10.1136/neurintsurg-2020-017184]

5. **Liu J,** He F, Wang XJ, Wang ME, Zhang TT, Hui X, Zhang LJ, Chen W, Sun HY. [Clinical prognoses of acute ischemic stroke patients with large core infarction after endovascular therapy and their influencing factors]. Zhonghua Shenjing Yixue Zazhi 2021; 20: 7 [DOI: 10.3760/cma.j.cn155354-20210326-00197]

6. **Panni P,** Gory B, Xie Y, Consoli A, Desilles JP, Mazighi M, Labreuche J, Piotin M, Turijn F, Eker OF, Bracard S, Axionnot R, Richard S, Hossu G, Blane R, Lapergue B, ETIS (Endovascular Treatment in Ischemic Stroke) Investigators. Acute Stroke With Large Ischemic Core Treated by Thrombectomy. Stroke 2019; 50: 1164-1171 [PMID: 31009354 DOI: 10.1161/STROKEAHA.118.024295]

7. **Kim BJ,** Menon BK, Kim JY, Shin DW, Baik SH, Jung C, Han MK, Demchuk A, Bae HJ. Endovascular Treatment After Stroke Due to Large Vessel Occlusion for Patients Presenting Very Late From Time Last Known Well. JAMA Neurol 2020; 76: 231-240 [PMID: 32037660 DOI: 10.1001/jamaneurol.2020.2804]

8. **Kakita H,** Yoshimura S, Uchiha K, Sakai N, Yamagami H, Morimoto T; RESCUE-Japan Registry 2 Investigators. Impact of Endovascular Therapy in Patients With Large Ischemic Core: Subanalysis of Recovery by Endovascular Salvage for Cerebral Ultra-Acute Embolism Japan Registry 2. Stroke 2019; 50: 901-908 [PMID: 31633899 DOI: 10.1161/STROKEAHA.118.024646]

9. **Rotkopf LT,** Tiedt S, Puhr-Westerheide D, Herzberg M, Reidler P, Kellert L, Feil K, Thierfelder KM, Dorn F, Liebig T, Wollenweber FA, Kunz WG. Ischemic Core Volume Combined with the Relative Perfusion Ratio for Stroke Outcome Prediction after Endovascular Thrombectomy. J Neuroimag 2020; 30: 321-326 [PMID: 32037660 DOI: 10.1111/jon.12659]

10. **Ko SB,** Park HK, Kim BM, Heo JH, Rha JH, Kwon SH, Kim JS, Lee BC, Suh SH, Jung C, Jeong HW, Kang DH, Bae HJ, Yoon BW, Hong KS. 2019 Update of the Korean Clinical Practice Guidelines of Stroke for Endovascular Recanalization Therapy in Patients with Acute Ischemic Stroke. J Stroke 2019; 21: 231-240 [PMID: 30991800 DOI: 10.5853/jos.2019.00024]

11. **Campbell BVC,** Majoe CBLM, Albers GW, Menon BK, Yassi N, Sharma G, van Zwan WH, van Oostenbrugge RJ, Demchuk AM, Guillemin F, White P, Ðávalos A, van der Lugt A, Butler KS, Cherifi A, Marquering HA, Cloud G, Macho Fernández JM, Madigan J, Oppenheim C, Donnan GA, Roos YB, Shankar J, Lingsma H, Bonafe A, Raoult H, Hernández-Perez M, Bharatha A, Jahan R, Jansen O, Richard S, Levy EI, Berkhemer OA, Soudant M, Aja L, Davis SM, Krings T, Tisserand M, San Román L, Tomasello A, Beumer D, Brown S, Liebskind DS, Bracard S, Muir KW, Dippel
DWJ, Goyal M, Saver JL, Jovin TG, Hill MD, Mitchell PJ; HERMES collaborators. Penumbra imaging and functional outcome in patients with anterior circulation ischaemic stroke treated with endovascular thrombectomy versus medical therapy: a meta-analysis of individual patient-level data. *Lancet Neurol* 2019; 18: 46-55 [PMID: 30413385 DOI: 10.1016/S1474-4422(18)30314-4]

**Manceau PF, Soize S, Gawlitza M, Fabre G, Bakchine S, Durot C, Serre I, Metaxas GE, Pierot L. Is there a benefit of mechanical thrombectomy in patients with large stroke (DWI-ASPECTS ≤ 5)? *Eur J Neurology* 2018; 25: 105-110 [PMID: 28906581 DOI: 10.1111/ene.13460]

**Nogueira RG, JadHAV AP, Haussen DC, Bonafe A, Budziki RF, Bhupu V, Yavagal DR, Ribo M, Cognard C, Hanel RA, SiLa CA, Hassan AE, Millan L, LeyVI EI, Mitchell P, Chen M, English JD, Shah QA, Silver FL, Pereira VM, Mehta BP, Baxter BW, Abraham MG, Cardona P, Veznedaroglu E, Hellinger FR, Feng L, Kirmani JF, Lopes DK, Jankowitz BT, Frankel MR, Costalat V, Vora NA, Yoo AJ, Malik AM, Furlan AJ, Rubiera M, Aghaebrahim A, Olovit JM, Tekle WG, Shields R, Graves T, Lewis RJ, Smith WS, Liebskind DS, Saver JL, Jovin TG; DAWN Trial Investigators. Thrombectomy 6 to 24 Hours after Stroke with a Mismatch between Deficit and Infarct. *N Engl J Med* 2018; 378: 11-21 [PMID: 29129157 DOI: 10.1056/NEJMoa1706442]

**Powers WJ, Rabinstein AA, Ackerson T, Adeoye OM, Bambakidis NC, Becker K, Biller J, Brown M, Demaerschalk BM, Hoh B, Jauch EC, Kidwell CS, Leslie-Mazwi TM, Ovbiagele B, Scott PA, Sheth KN, Southerland AM, Summers DV, Tirschwell DL; American Heart Association Stroke Council. 2018 Guidelines for the Early Management of Patients With Acute Ischemic Stroke: A Guideline for Healthcare Professionals From the American Heart Association/American Stroke Association. *Stroke* 2018; 49: e46-e110 [PMID: 29367334 DOI: 10.1161/STR.0000000000000158]

**Albers GW, Marks MP, Kemp S, Christensen S, Tsai JP, Ortega-Gutierrez S, McGtaggart RA, Torbery MT, Kim-Tenser M, Leslie-Mazwi T, Sarraj A, Kasner SE, Ansari SA, Yeatts SD, Hamilton S, Mlynash M, Heit JJ, Zaharchuk G, Kim S, Carrozella I, Pambile P, Lavioli Y, Demchuk J, Lunsberg MG; DEFUSE 3 Investigators. Thrombectomy for Stroke at 6 to 16 Hours with Perfusion Imaging. *N Engl J Med* 2018; 378: 708-718 [PMID: 29364767 DOI: 10.1056/NEJMoa1713973]

**Son S, Kang DH, Hwang YH, Kim YS, Kim YW. Efficacy, safety, and clinical outcome of modern mechanical thrombectomy in elderly patients with acute ischemic stroke. *Acta Neurochir* (Wien) 2017; 159: 1663-1669 [PMID: 28730457 DOI: 10.1007/s00701-017-3269-y]

**Miszczuk M, Baudknecht HC, Kleine JF, Liebig T, Bohner G, Siebert E. Direct puncture of the carotid artery as a bailout vascular access technique for mechanical thrombectomy in acute ischemic stroke-the revival of an old technique in a modern setting. *Neuroradiology* 2021; 63: 275-283 [PMID: 32803336 DOI: 10.1007/s00234-020-02520-x]

**Venditti L, Chassin O, Aneckel C, Legris N, Sarov M, Lapergue B, Mihalea C, Ozanne A, Gallas S, Cortese J, Chalumeau V, Ikka L, Caroff J, Labreuche J, Spelle L, Denier C. Pre-procedural predictive factors of symptomatic intracranial hemorrhage after thrombectomy in stroke. *J NeuroInterventional Surg* 2021; 268: 1867-1875 [PMID: 33598028 DOI: 10.1007/s00415-020-10364-x]

**Jia B, Ren Z, Mokin M, Burgin WS, Bauer CT, Fiederl J, Mo D, Ma N, Gao F, Huo X, Luo G, Wang A, Pan Y, Song L, Sun X, Zhang X, Gui L, Song C, Peng Y, Wu J, Zhao S, Zhao J, Zhou Z, Li Y, Jing P, Yang L, Liu Y, Zhao Q, Peng X, Gao Q, Guo Z, Chen W, Li W, Cheng X, Xu Y, Zhang Y, Zhang G, Lu Y, Lu X, Wang D, Wang Y, Li H, Ling L, Peng G, Zhang J, Zhang K, Li S, Qi Z, Xu H, Tong X, Ma G, Liu R, Guo X, Deng Y, Leng X, Leung TW, Liebskind DS, Miao Z; ANGEL-ACT Study Group†. Current Status of Endovascular Treatment for Acute Large Vessel Occlusion in China: A Real-World Nationwide Registry. *Stroke* 2021; 52: 1203-1212 [PMID: 33596674 DOI: 10.1161/STROKEAHA.120.031869]

**Zhang X, Xie Y, Wang H, Yang D, Jiang T, Yuan K, Gong P, Xu P, Li Y, Chen J, Wu M, Sheng L, Liu D, Liu X, Xu G. Symptomatic Intracranial Hemorrhage After Mechanical Thrombectomy in Chinese Ischemic Stroke Patients: The ASIcon Score. Stroke *2020; 51: 2690-2696 [PMID: 32811387 DOI: 10.1161/STR.0000000000003017]

**Pannu P, Gorry B, Xie Y, Consoli A, Desilles JP, Magzibi M, Labreuche J, Piotin M, Turjman F, Eker OF, Bracard S, Anxionnat R, Richard S, Hossu G, Blanc R, Lapergue B; ETIS (Endovascular Treatment in Ischemic Stroke) Investigators. Acute Stroke With Large Ischemic Core Treated by Thrombectomy. *Stroke* 2019; 50: 1164-1171 [PMID: 31009354 DOI: 10.1161/STROKEAHA.118.024295]

**Kaesmacher J, Chaloulos-Iakovassakis P, Panos L, Mordini S, Michel P, Hajdu SD, Ribo M, Requena M, Maegerlein C, Friedrich B, Costalat V, Benalh A, Pierot L, Gawlitza M, Schaafsmaj J, Mendes Pereira V, Grall J, Fischer U. Mechanical Thrombectomy in Ischemic Stroke Patients With Alberta Stroke Program Early Computed Tomography Score 0-5. *Stroke* 2019; 50: 880-888 [PMID: 310827493 DOI: 10.1161/STROKEAHA.118.025423]

**Duan YX, Zhao Y, Pei HL, Chen SQ, Lyu PY. [Relationship between cerebral small vessel disease and the outcome after intravascular thrombectomy in patients with acute ischemic stroke]. *Guoji Naoxueguanbing Zazhi* 2021; 29: 602-607 [DOI: 10.3760/cnrj.issn.1673-4165.2021.08.008]

**Campbell BVC. Selecting Patients With Large Ischemic Core Who May Benefit From Endovascular Reperfusion. *JAMA* 2019; 176: 1140-1142 [PMID: 31355867 DOI: 10.1001/jamaneurol.2019.1789]

**Powers WJ, Rabinstein AA, Ackerson T, Adeoye OM, Bambakidis NC, Becker K, Biller J, Brown M, Demaerschalk BM, Hoh B, Jauch EC, Kidwell CS, Leslie-Mazwi TM, Ovbiagele B, Scott PA, Sheth KN, Southerland AM, Summers DV, Tirschwell DL; 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 Association. *Stroke* 2019; 50: e344-e418 [PMID: 31662037 DOI: 10.1161/STR.0000000000002211]

**Hou X, Chen H. Proposed antithrombotic strategy for acute ischemic stroke with large-artery atherosclerosis: focus on patients with high-risk transient ischemic attack and mild-to-moderate stroke. *Ann Trans Med* 2020; 8: 16 [PMID: 32055607 DOI: 10.21037/atm.2019.10.111]

**Saber H, Khatibi K, Szedev V, Tatheshima S, Colby GP, Nour M, Jahan R, Duckwiler G, Liebskind DS, Saver JL. Reperfusion Therapy Frequency and Outcomes in Mild Ischemic Stroke in the United States. *Stroke* 2020; 51: 3241-3249 [PMID: 33081604 DOI: 10.1161/STR.0000000000002089]
28 Liu HW, Ye F. [Effect of rt-PA thrombolysis combined with antiplatelet therapy on recurrent cardiovascular and cerebrovascular events in patients with mild acute ischemic stroke]. Zhongguo Jiceng Yiya 2019; 26: 461-465 [DOI: 10.3760/cmr.j.issn.1008-6706.2019.04.020]

29 Wang Z, Song HQ. [Research progress on endovascular treatment of acute ischemic stroke]. Zhongguo Naoxueguanbing Zazhi 2021; 18: 3 [DOI: 10.3969/j.issn.1672-5921.2021.01.013]
