Case Report

Mechanical thrombectomy in an 18-month-old infant with acute ischemic stroke with large core infarct and late time window: a case report

Bin Zhao[1], Taining Zhang[2], Ruifeng Xu[3], Weikai Wang[2], Rong Yin[1]

[1]Department of Neurology, Gansu Provincial Central Hospital, Lanzhou, China; [2]Department II of Children's ICU, Gansu Provincial Central Hospital, Lanzhou, China; [3]Department I of Children's ICU, Gansu Provincial Central Hospital, Lanzhou, China

Contributions: (I) Conception and design: R Yin; (II) Administrative support: W Wang; (III) Provision of study materials or patients: R Xu; (IV) Collection and assembly of data: T Zhang; (V) Data analysis and interpretation: B Zhao; (VI) Manuscript writing: All authors; (VII) Final approval of manuscript: All authors.

Correspondence to: Rong Yin, MD, PhD. Department of Neurology, Gansu Provincial Central Hospital, #999 Mogao Avenue, Anning District, Lanzhou 730070, China. Email: yin_rong_@hotmail.com; Weikai Wang, MD. Department II of Children's ICU, Gansu Provincial Central Hospital, #999 Mogao Avenue, Anning District, Lanzhou 730070, China. Email: 35487284@qq.com.

Background: Mechanical thrombectomy (MT) is recognized as the most effective treatment for acute cerebral artery occlusion in adults. However, due to the rarity of acute ischemic stroke (AIS) in children and the lack of robust clinical evidence, the benefits of MT for pediatric patients remain uncertain. This case study aims to provide valuable insights into the treatment considerations for pediatric stroke patients and address various intraoperative and postoperative challenges.

Case Description: In this report, we present a case involving an 18-month-old infant who suffered from a stroke. An emergency head magnetic resonance imaging (MRI) and magnetic resonance angiography (MRA) performed approximately 30 hours after onset revealed extensive infarction in the left basal ganglia, temporal and parietal lobes, along with occlusion of the left internal carotid artery and middle cerebral artery. Two hours after the imaging examination, the attending pediatrician noted a decline in muscle strength (grade 0) in the right limb and mild drowsiness. Despite the late time window and large core infarction, a thorough clinical and imaging evaluation indicated the presence of salvageable brain tissue. Following MT and subsequent multidisciplinary management, there was a significant reduction in the final infarct volume, preserving brain function. At a 6-month follow-up, the pediatric modified Rankin Scale (mRS) score improved to 1 point, indicating favorable outcomes.

Conclusions: Although our patient has a good prognosis after thrombectomy, surgery should be carefully selected in the face of stroke caused by large vessel occlusion in pediatric patients.

Keywords: Mechanical thrombectomy (MT); infant; acute ischemic stroke (AIS); large core; case report

Submitted Oct 27, 2024. Accepted for publication Feb 09, 2025. Published online Feb 25, 2025.
doi: 10.21037/tp-24-463
View this article at: https://dx.doi.org/10.21037/tp-24-463

Introduction

Since the publication of five pivotal studies in 2015, mechanical thrombectomy (MT) has emerged as the foremost treatment modality for acute ischemic stroke (AIS) in adults (1). With an increasing body of evidence from randomized controlled trials (RCTs), this technique is gradually being extended to encompass large core infarctions (2,3), occlusions of small and medium-sized vessels (4), and vertebrobasilar artery occlusions (5,6). The ongoing multi-center RCT on MT beyond a 24-hour time window aims to provide substantial evidence regarding the potential benefits of this intervention for patients with delayed presentation of AIS (7).

However, the incidence of stroke in children is significantly lower than in adults, ranging from 2 to 8 per 100,000 (8). Additionally, the etiology in children differs from that in adults (9), and ethical, logistical and feasibility considerations complicate the conduct of multi-center, large-sample RCTs to establish evidence supporting the benefits of MT for pediatric stroke patients (10). Particularly when faced with a toddler presenting with progressive AIS characterized by extensive core infarction and a time window exceeding 24 hours, clinicians encounter an exceedingly complex decision-making process. In this report, we present such a unique case, aiming to provide valuable insights into treatment selection, as well as etiological factors associated with childhood stroke. We present this article in accordance with the CARE reporting checklist (available at https://tp.amegroups.com/article/view/10.21037/tp-24-463/rc).

Case presentation

The patient, an 18-month-old healthy boy weighing 11 kg, experienced diarrhea 4 days prior to admission. The day before presenting at the hospital, his mother noticed weakness in his right upper limb in the morning and in his right lower limb by the afternoon. The local hospital did not provide a definitive diagnosis. Physical examination revealed lethargy, deviation of gaze to the right, muscle strength level 2 in the right limb, positive Babinski sign in both lower limbs, and a Pediatric National Institutes of Health Stroke Scale (Ped NIHSS) score of 13 points. Emergency head magnetic resonance imaging (MRI) and magnetic resonance angiography (MRA) showed extensive infarction involving the left middle cerebral artery territory and occlusion of the left internal carotid artery with no flow in the middle cerebral artery (*Figure 1A-1D*).

Two hours after the imaging examinations, the child's muscle strength in the right limb had deteriorated to grade 0, with mild drowsiness present. An urgent online multidisciplinary team (MDT) discussion led to the decision for immediate MT surgery. The patient was transferred from a local hospital 16 km away to our stroke center with an interventional complex operating room for further management. Under general anesthesia, a right femoral artery puncture was performed, achieving a door-to-puncture time of 20 minutes using a 6-F femoral sheath insertion technique. A single aspiration pass with a 5-F intermediate catheter at the distal left internal carotid artery successfully retrieved the embolic material, followed by the deployment of a 3 mm × 20 mm Reco stent combined with suction pump assistance. Superselective access into an occluded M2 branch using an XT-27 microcatheter allowed additional aspiration, resulting in reestablishment of blood flow and achieving Thrombolysis in Cerebral Infarction (TICI) grade 2b recanalization status (*Figure 1E-1H*). The procedure lasted approximately 45 minutes from puncture to recanalization, using 60 mL of contrast medium. After the operation and the first 3 days, we touched the dorsalis pedis artery pulse and auscultated the femoral artery puncture point area to ensure normal blood vessels.

During the operation and for up to 48 hours post-operation, Tirofiban was continuously administered via an intravenous pump at a rate of 1 mL/h. After a 4-hour overlap period, the treatment was switched to clopidogrel (10 mg) and Atherosclerosis Society of America (ASA) (50 mg). Following the surgery, the child was admitted to the pediatric intensive care unit (PICU), where they underwent endotracheal intubation, sedation, analgesia, mild hypothermia treatment, and anti-infection therapy. Echocardiography was performed after the procedure and was generally normal. A head CT scan conducted 24 hours after the surgery revealed a patchy low-density shadow in the left frontal lobe, in addition to the existing low-density shadow in the left middle cerebral artery region (*Figure 1I*). The patient needed to remain intubated for 5 days because of the pulmonary infection, which resulted in a disappearance of gaze in the child.

On day 9 post-surgery, a reexamination with head MRI, MRA, and perfusion weighted imaging (PWI) showed a significant reduction in the diffusion weighted imaging (DWI) range, with good vascular recanalization observed in

Highlight box

Key findings

- Our case of a pediatric acute stroke patient with extensive core infarction extended 24-hour time window by mechanical thrombectomy (MT) achieved a favorable outcome.

What is known and what is new?

- The benefits of MT for pediatric patients remain uncertain.
- This case study aims to provide valuable insights into the treatment considerations for pediatric stroke patients and address various intraoperative and postoperative challenges.

What is the implication, and what should change now?

- Despite the evolving recommendations by American Heart Association and the Atherosclerosis Society of America, which now emphasize potential selection criteria and multidisciplinary approaches in children, caution is still warranted when treating pediatric stroke.

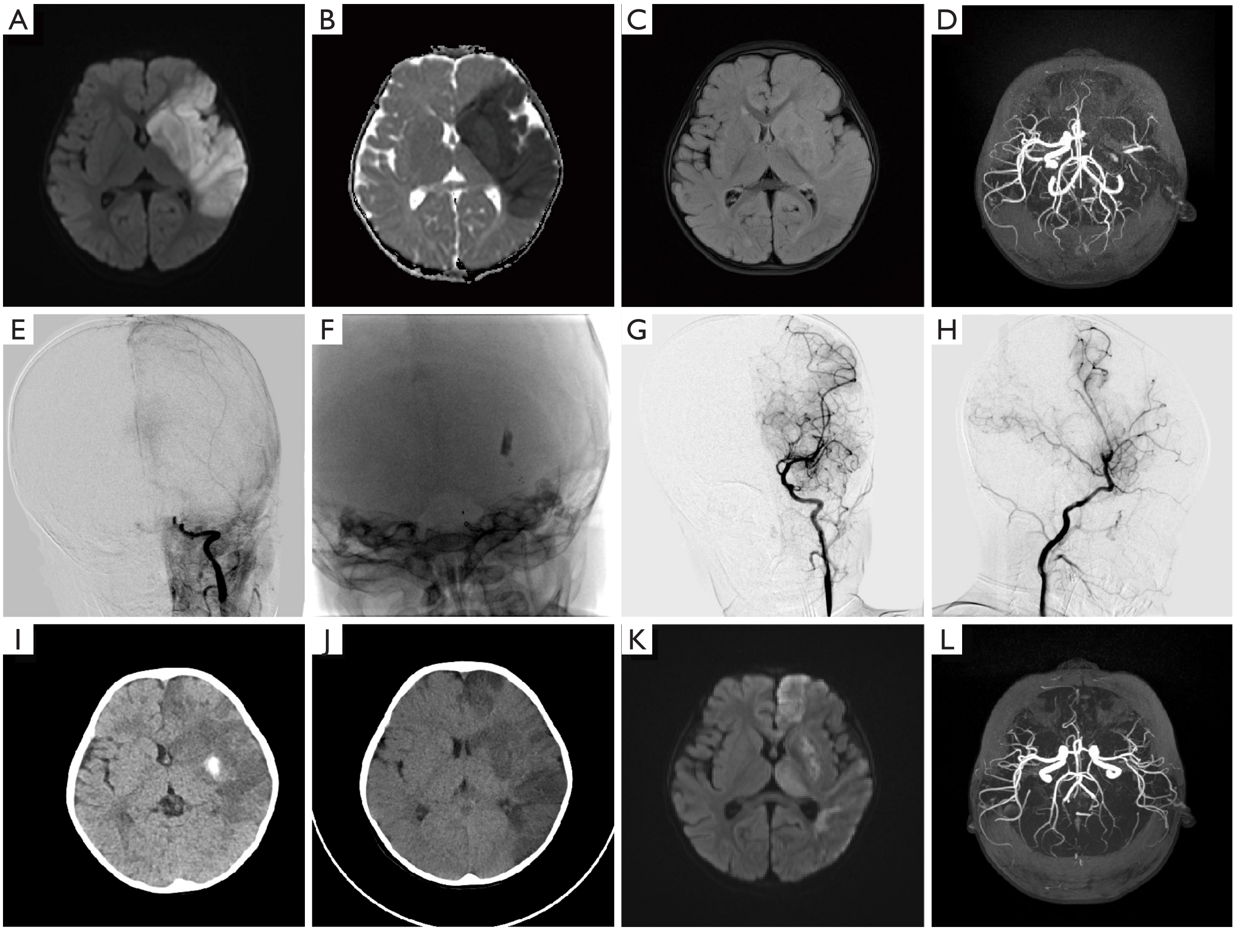

Figure 1 Intracranial images of the patient children before and after interventional surgery. (A) A large infarct in the region of the left middle cerebral artery shown on cranial MRI-DWI sequences at 32 hours after ischaemic stroke. (B) The infracted region appearing low signal in ADC sequences. (C) The infracted region appearing abnormal high signal in FLAIR sequences, the mismatch between FLAIR and DWI was also found. (D) Occlusion of the left internal carotid artery and middle cerebral artery imaged by MRA. (E) Terminal occlusion of the left internal carotid artery confirmed by DSA. (F) Coverage of the thrombus with the Reco embolic stent and aspiration of the thrombus in the proximal internal carotid artery with a 5-F intermediate catheter. (G) Restoration to TICI 2B for the forward blood flow of the left internal carotid artery. (H) Forward blood flow to one branch of the left middle cerebral artery remaining unrecovered. (I) Contrast medium extravasation from the left basal ganglia region and hypodense shadow of the left frontal lobe shown on head CT at 24 hours after interventional surgery. (J) Scattered patchy hypodense shadows in the left hemisphere on the postoperative head CT 72 hours. (K) MRI-DWI sequences at the postoperative 9th day. (L) MRA imaging at the postoperative 9th day. MRI, magnetic resonance imaging; DWI, diffusion weighted imaging; ADC, apparent diffusion coefficient; FLAIR, fluid attenuated inversion recovery; MRA, magnetic resonance angiography; DSA, digital subtraction angiography; TICI, thrombolysis in cerebral infarction; CT, computed tomography.

both the left internal carotid artery and left middle cerebral artery regions (*Figure 1J-1L*). Perfusion indicated slight improvement over the opposite side. At discharge on day 14, the Ped NIHSS score was recorded as 7 points, while the child's improved pediatric modified Rankin Scale (mRS) score reached 4 points following continuous rehabilitation training. During hospitalization, anemia was detected (hemoglobin 95 g/L). Elevated fasting blood glucose levels and glycosylated hemoglobin indicated the presence of type-1 diabetes. Elevated anti-cardiolipin antibody immunoglobulin M (IgM) and immunoglobulin G (IgG) levels suggested antiphospholipid antibody syndrome as a potential etiology; however, no corresponding mutation was identified through whole gene sequencing analysis. After 6 months

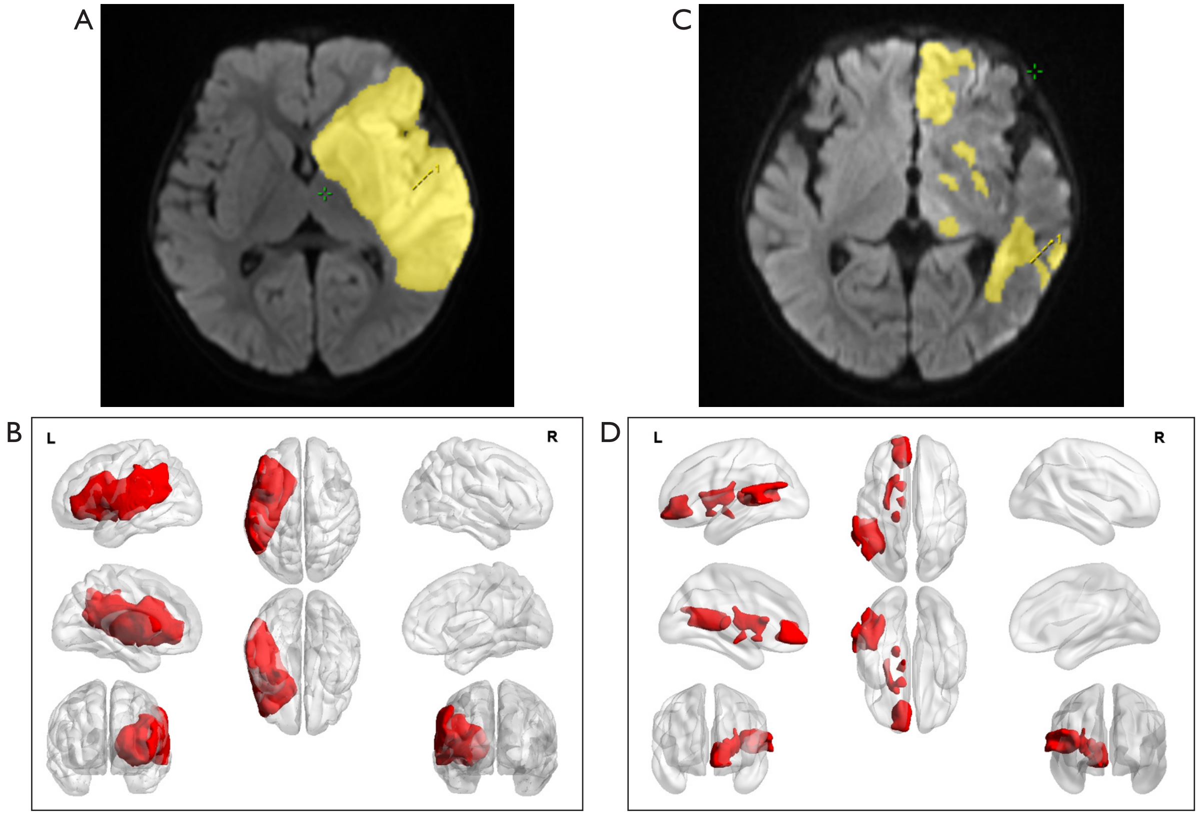

Figure 2 Changes in the core infracted area of ischemic stroke before and after interventional surgery. (A) The core area of infraction shown on MRI-DWI sequences before interventional surgery (the yellow-highlighted region). (B) 3D reconstruction of the core infracted area with MRI-DWI imaging before interventional surgery, 136 mL of infracted volume (the red-highlighted regions). (C) The core infracted area shown on MRI-DWI sequences at the postoperative 9th day (the yellow-highlighted regions). (D) 3D reconstruction of the core infracted area with MRI-DWI imaging at the postoperative 9th day, 22.8 mL of infracted volume (the red-highlighted regions). MRI, magnetic resonance imaging; DWI, diffusion weighted imaging; 3D, three-dimensional.

of rehabilitation training, the child's improved pediatric mRS score reached 1 point. All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee(s) and with the Helsinki Declaration (as revised in 2013). Written informed consent was obtained from the patient for publication of this case report and accompanying images. A copy of the written consent is available for review by the editorial office of this journal.

Discussion

The mortality rate following acute stroke is lower in pediatric patients compared to adults, and the prognosis is generally more favorable in children than in adults receiving drug therapy or small sample thrombectomy (9,10). Although reports and reviews on thrombectomy cases in children are limited, most demonstrate a positive prognosis. The Save Child studies suggest that MT yields better outcomes than drug therapy for large blood vessel occlusion in children (11,12). However, due to biased reporting and a lack of large-scale multi-center prospective RCTs, high-grade clinical evidence for acute stroke with large vessel occlusion remains insufficient among pediatric patients (9). Furthermore, obtaining high-grade evidence within the next few years seems highly unlikely due to objective factors such as ethical considerations and low morbidity rates, presenting a significant challenge for clinicians.

Our patient experienced an acute stroke, with magnetic resonance (MR) DWI indicating an infarct volume of 136 mL after left middle cerebral artery occlusion (*Figure 2A,2B*), surpassing the 24-hour time window recommended for adults according to guidelines. With this extended timeframe, the child exhibited clinical deterioration with progressive worsening hemiplegia over more than 30 hours since onset and weakened consciousness two hours prior to surgery. Imaging evaluation suggested a mismatch between fluid attenuated inversion recovery (FLAIR) and DWI findings. Based on adult clinical studies emphasizing tissue rather than time windows (7), results from the Angio-ASPECT study (2), SELECT-2 trial (3), and RESCUE-JAPAN study (13) indicate that ischemic penumbra may exist even within larger core infarctions, supporting potential benefits of MT intervention. A subanalysis of the Save Child study provides evidence that MT is safe, even within 24 hours of symptom onset, if selected based on a mismatch between clinical defect and infarction (14).

Consequently, we opted to perform interventional surgery to reopen the vessel after a rapid MDT discussion. Fortunately, postoperative hemorrhage or malignant cerebral edema with hyperperfusion did not occur. Nine days after surgery, the MR DWI infarct volume decreased to 23 mL (*Figure 2C,2D*), and the Ped NIHSS score decreased from 13 to 7 points. The significant reduction in core infarction may be attributed to robust collateral compensation and neural plasticity observed in children. This raises an intriguing question: is the DWI infarct area considered an irretrievable core infarct area in children? In other words, do children exhibit irreversible infarction at lower perfusion levels compared to adults with perfusion below 25 mL/min where high DWI signal appears? Therefore, it is possible that the same threshold defining critical hypoperfusion in adults may not be applicable for children (15).

Similar challenges are reported in other literature regarding childhood stroke identification (8-10). Due to children's limited ability for accurate expression, especially infants, and atypical onset symptoms, timely identification by parents and doctors becomes challenging, leading to misdiagnosis or missed diagnosis, resulting in lower rates of thrombolysis administration among pediatric patients (10,12). Although studies suggest the safety of thrombolysis treatment for children (12,14,16), physicians still have concerns due to a lack of more objective high-level evidence. Studies have demonstrated a significantly lower growth rate of thrombolysis and thrombolysis rates in pediatric specialty hospitals over the past decade compared to general hospitals, which may be attributed to the rapid advancement of stroke centers' expertise in general hospitals (17). To facilitate prompt identification and appropriate treatment, it is imperative to enhance collaboration, education, and training between pediatric specialty and neurological specialty within the region.

Interventional surgery for acute stroke in children due to occlusion of large blood vessels still faces numerous inevitable challenges. Firstly, the selection of a safe contrast medium and determining its optimal dosage limit remain uncertain (18). Secondly, radiation exposure during surgery could develop radiation-induced cancer in children (19), and despite employing low-dose models, the potential risk of developing cancer is still unknown. In our case, to minimize radiation exposure, we refrained from repeating CT perfusion imaging (CTP) examination after confirming MR diagnosis and opted for nuclear magnetic arterial spin labeling (ASL) perfusion mode during review, although it may be less accurate than PWI or CTP with contrast agent injection. Lastly, there is insufficient high-level evidence regarding the dosage and usage of antiplatelet agents such as tirofiban, aspirin, and clopidogrel in pediatric cases (8); hence we can only rely on adult experiences. However, until prognosis is determined, it remains unpredictable whether proportional reduction based on the weight ratio between adults and children would increase bleeding risk or result in inadequate antithrombotic effect (8,10,17). These factors contribute significantly to the prolonged duration required for the completion of RCTs.

The etiology of stroke in pediatric patients differs significantly from that in adults. In the Prospective Vascular Effects of Infection in Pediatric Stroke study, a centralized classification was conducted on 355 children with arterial ischemic stroke enrolled in academic centers (20). The majority of cases fell into two main categories: arterial disease (45%) or cardiac embolism (30%) (20). Other patients presented with true idiopathic cases, where no identifiable risk factors were found, as well as cases where one or several risk factors were present but did not fully explain the occurrence of stroke (9). In our case, antiphospholipid antibody syndrome and type 1 diabetes were identified; however, genome-wide screening did not reveal any hereditary factors. Nonetheless, a gene mutation potentially related to phospholipid metabolism was detected, which may have contributed to an increased susceptibility to thrombolysis following diarrhea and subsequent development of cerebral embolism.

Conclusions

Our case of a pediatric acute stroke patient with extensive core infarction extended 24-hour time window demonstrated a favorable outcome following MT, providing evidence for the future management of childhood stroke. Despite the evolving recommendations by the American Heart Association (AHA) and the ASA, which now emphasize potential selection criteria and multidisciplinary approaches in children (21), caution is still warranted when treating pediatric stroke.

Acknowledgments

None.

Footnote

Reporting Checklist: The authors have completed the CARE reporting checklist. Available at https://tp.amegroups.com/article/view/10.21037/tp-24-463/rc

Peer Review File: Available at https://tp.amegroups.com/article/view/10.21037/tp-24-463/prf

Funding: This study was supported by the Natural Science Foundation of Gansu Province (Nos. 22JR5RA720 and 23ZDFA012) and Major Research Projects of the Gansu Center Hospital (No. ZDGG-2023-002).

Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at https://tp.amegroups.com/article/view/10.21037/tp-24-463/coif). The authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee(s) and with the Helsinki Declaration (as revised in 2013). Written informed consent was obtained from the patient for publication of this case report and accompanying images. A copy of the written consent is available for review by the editorial office of this journal.

References

1. Saver JL, Goyal M, van der Lugt A, et al. Time to Treatment With Endovascular Thrombectomy and Outcomes From Ischemic Stroke: A Meta-analysis. JAMA 2016;316:1279-88.
2. Huo X, Ma G, Tong X, et al. Trial of Endovascular Therapy for Acute Ischemic Stroke with Large Infarct. N Engl J Med 2023;388:1272-83.
3. Sarraj A, Hassan AE, Abraham MG, et al. Trial of Endovascular Thrombectomy for Large Ischemic Strokes. N Engl J Med 2023;388:1259-71.
4. Jumaa MA, Castonguay AC, Salahuddin H, et al. Middle Cerebral Artery M2 Thrombectomy in the STRATIS Registry. Stroke 2021;52:3490-6.
5. Tao C, Nogueira RG, Zhu Y, et al. Trial of Endovascular Treatment of Acute Basilar-Artery Occlusion. N Engl J Med 2022;387:1361-72.
6. Alemseged F, Nguyen TN, Alverne FM, et al. Endovascular Therapy for Basilar Artery Occlusion. Stroke 2023;54:1127-37.
7. Rodriguez-Calienes A, Galecio-Castillo M, Vivanco-Suarez J, et al. Endovascular thrombectomy beyond 24 hours from last known well: a systematic review with meta-analysis. J Neurointerv Surg 2024;16:670-6.
8. Oborska Z, Urban P, Wychowaniec K, et al. Paediatric stroke - a review of current guidelines for diagnosis and treatment. Neurol Neurochir Pol 2020;54:116-24.
9. Sporns PB, Fullerton HJ, Lee S, et al. Current treatment for childhood arterial ischaemic stroke. Lancet Child Adolesc Health 2021;5:825-36.
10. Hollist M, Au K, Morgan L, et al. Pediatric Stroke: Overview and Recent Updates. Aging Dis 2021;12:1043-55.
11. Sporns PB, Sträter R, Minnerup J, et al. Feasibility, Safety, and Outcome of Endovascular Recanalization in Childhood Stroke: The Save ChildS Study. JAMA Neurol 2020;77:25-34.
12. Rivkin MJ, deVeber G, Ichord RN, et al. Thrombolysis in pediatric stroke study. Stroke 2015;46:880-5.
13. Yoshimura S, Sakai N, Yamagami H, et al. Endovascular Therapy for Acute Stroke with a Large Ischemic Region. N Engl J Med 2022;386:1303-13.
14. Sporns PB, Psychogios MN, Straeter R, et al. Clinical Diffusion Mismatch to Select Pediatric Patients for

Embolectomy 6 to 24 Hours After Stroke: An Analysis of the Save ChildS Study. Neurology 2021;96:e343-51.
15. Kochanek PM, Adelson PD, Rosario BL, et al. Comparison of Intracranial Pressure Measurements Before and After Hypertonic Saline or Mannitol Treatment in Children With Severe Traumatic Brain Injury. JAMA Netw Open 2022;5:e220891.
16. Sun LR, Felling RJ, Pearl MS. Endovascular mechanical thrombectomy for acute stroke in young children. J Neurointerv Surg 2019;11:554-8.
17. Barry M, Barry D, Kansagra AP, et al. Higher-Quality Data Collection Is Critical to Establish the Safety and Efficacy of Pediatric Mechanical Thrombectomy. Stroke 2021;52:1213-21.
18. ACR Committee on Drugs and Contrast Media. ACR Manual on Contrast Media; 2020.
19. Sadetzki S, Mandelzweig L. Childhood exposure to external ionising radiation and solid cancer risk. Br J Cancer 2009;100:1021-5.
20. Wintermark M, Hills NK, deVeber GA, et al. Arteriopathy diagnosis in childhood arterial ischemic stroke: results of the vascular effects of infection in pediatric stroke study. Stroke 2014;45:3597-605.
21. Ferriero DM, Fullerton HJ, Bernard TJ, et al. Management of Stroke in Neonates and Children: A Scientific Statement From the American Heart Association/American Stroke Association. Stroke 2019;50:e51-96.

Cite this article as: Zhao B, Zhang T, Xu R, Wang W, Yin R. Mechanical thrombectomy in an 18-month-old infant with acute ischemic stroke with large core infarct and late time window: a case report. Transl Pediatr 2025;14(2):322-328. doi: 10.21037/tp-24-463

