Review

Mechanical Thrombectomy in Pregnancy: Report of 2 Cases and Review of the Literature

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Keywords

Mechanical thrombectomy · Pregnancy

Abstract

Background: Mechanical thrombectomy has recently proved extremely effective in improving the outcome of patients with large vessel occlusion. Despite this, questions still remain over certain cohorts of patients that were excluded from the large randomised controlled trials. One such cohort includes pregnant patients. Although thromboembolic stroke is uncommon in pregnancy, the outcome from this pathology can be devastating. **Summary:** We present 2 cases of mechanical thrombectomy in pregnancy both of which underwent successful flow restoration without complications. We discuss the incidence of stroke in pregnancy, potential pitfalls of imaging, radiation protection issues, and the role of thrombolysis as well as the available literature on mechanical thrombectomy in this cohort. **Key Message:** Thrombectomy in pregnancy can be performed safely with no significant changes required to the procedure itself. Radiation exposure during the procedure should be minimised and shielding used to prevent scatter radiation to the fetus; however, given the potential risks of thrombolysis in this cohort of patients, mechanical thrombectomy should be considered in all stages of pregnancy.

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Introduction

Mechanical thrombectomy has recently been shown to be an extremely effective treatment modality for patients suffering from acute large vessel thromboembolic occlusion. Despite the wealth of data concerning this treatment there are still several questions that need to be answered. One of these questions is the potential for this treatment modality to be used in pregnant patients. Here we present 2 cases of mechanical thrombectomy during pregnancy. We discuss the clinical presentation, imaging, operative technique, and outcomes.

Cases

Case 1

A 38-year-old patient was rushed to the emergency department of her local hospital due to sudden right-sided hemiparesis and global aphasia. The initial non-contrast cranial CT showed hyperdensity along the left middle cerebral artery (MCA). The patient was in the 24th gestational week of her first pregnancy. Aside from previous drug abuse, the past medical history was unremarkable. Initial management consisted of 500 mg acetylsalicylic acid and 5,000 IU of unfractionated heparin that were administered intravenously; the patient was then transferred to our tertiary centre for further evaluation and treatment. On admission she was aphasic with deviated gaze to the left and complete right-sided hemiplegia and hemianaesthesia (NIHSS score 15). The emergent MRI showed restricted diffusion of the left lentiform nucleus and the insular cortex (ASPECTS score 6) (Fig. 1a). There was no significant demarcation of the cortical MCA territory. Due to delayed presentation beyond the therapeutic window and the size of the infarct on T2-weighted imaging, the decision was made not to give intravenous thrombolysis, and she was transferred to the angiography suite for mechanical thrombectomy.

After placement of an 8-Fr arterial sheath into the right common femoral artery, angiography confirmed an occlusion of the terminal internal carotid artery (ICA) (Fig. 1b) on the left with good collaterals to the left MCA through the leptomeningeal anastomoses from the anterior cerebral artery, which filled via the anterior communicating artery, and the posterior cerebral artery (PCA). After securing an 8-Fr guide catheter in the left cervical ICA (Guider Softip XF; Boston Scientific), a Rebar 27 microcatheter (Medtronic) was navigated distal to the site of occlusion in the left MCA, and a 4 × 20 mm Solitaire AB Stent (Medtronic) was deployed at the site of the occlusion, confirmed by injection through the guiding catheter (Fig. 2a). After retraction of the stent and with continuous manual aspiration on the guide catheter, the vessel remained occluded (Fig. 2b). After a second passage and successful placement of the microcatheter distal to the occlusion, the same stent was deployed again and a total of 9 mg of alteplase was infused intra-arterially over 20 min; however, the vessel immediately occluded again upon retrieval of the stent.

After another passage and the third deployment of the stent, it was electrically detached and permanently implanted, resulting in subtotal perfusion of the left MCA (TICI scale score IIb) (Fig. 3a). The total radiation exposure during the procedure was 15,133 mGy · m². The total time to recanalisation after symptom onset was 11 h 25 min, with the time from symptom onset to initial imaging being 3 h 52 min and the total duration of the interventional procedure being 6 h 7 min. The patient was given loading doses of both aspirin and clopidogrel (500 mg i.v. aspirin and 300 mg clopidogrel) and platelet function was checked using point-of-care testing (VerifyNow [Accumetrics] and Multiplate [Roche]). She was continued on aspirin 100 mg lifelong and clopidogrel 75 mg for 3 months.

The patient was successfully extubated the following day, and after 48 h of monitoring in the ICU she was transferred to the stroke unit. The initial aphasia and right hemiparesis improved markedly after physical therapy and speech therapy, with only mild residual paresis of the right hand on the last follow-up 8 years after the stroke (modified Rankin Scale [mRS] score 1) (Fig. 3b, c). The diagnostic work-up showed a patent foramen ovale as the most likely cause of the embolic occlusion. An emergent caesarean section was unnecessary, and the baby was delivered vaginally at term with the patient converted to heparin 1 week prior to the induced delivery. There were no complications from the delivery and no excess bleeding. The child, currently 8 years old, is healthy and reached all normal milestones as expected; there is no evidence of congenital abnormality.

Fig. 1. **a** Restricted diffusion was seen, involving the lentiform nucleus and insular cortex of the left (ASPECTS score 6) with no haemorrhage and no involvement of the middle cerebral artery cortical territory elsewhere. **b** Angiography of the left internal carotid artery showing occlusion of the terminal left internal carotid artery.

Fig. 2. **a** Angiography with the stent retriever in situ confirmed the location of the clot and passage of contrast distal to the clot. **b** After removal of the stent, the vessel immediately occluded.

Fig. 3. Angiography at the end of the procedure (**a**), after deployment of the Solitaire stent, confirmed vessel patency and good opacification of the distal vascular tree (TICI scale score IIb). The most recent angiography, performed 8 years after the treatment, confirms vessel patency (**b**), and cystic gliosis is seen on delayed coronal T2-weighted MRI (**c**).

Case 2

A 36-year-old female was rushed to the emergency department after rapid deterioration of consciousness. Shortly before becoming stuporous, she complained of headache, blurred vision, and nausea, and she had several episodes of vomiting. She was initially taken to her local hospital in an unconscious state, and upon arrival was intubated; therefore, her NIHSS score could not be assessed. The patient was in the 25th gestational week of her fourth pregnancy. The past medical history was notable for operative reconstruction of the ascending aorta after type A dissection. An emergent CT/CTA showed a distal occlusion of the basilar artery but no definite infarction (Fig. 4).

Fig. 4. A hyperdense basilar artery (white arrow) can be seen on the axial unenhanced CT scan, with no definite infarction.

A total dose of 36 mg alteplase (i.v.) was administered on recommendation of the attending neurologist, and the patient was then transferred to our tertiary centre for mechanical thrombectomy. The fetal ultrasound done in the angiography suite showed good vital signs, and an appropriate dose of corticosteroids was administered in anticipation of an emergent caesarean section.

The procedure was carried out through an 8-Fr introducer sheath placed in the right common femoral artery; an additional 4-Fr introducer sheath was inserted into the left common femoral artery for periodic injection of the anterior circulation using a diagnostic catheter. An initial 3-vessel angiogram confirmed an occlusion of the basilar artery (Fig. 5a) distal to the origin of the anterior inferior cerebellar artery with adequate perfusion of the PCA bilaterally through the posterior communicating arteries. The 8-Fr guide catheter (Guider Softip XF; Boston Scientific) was initially placed at the origin of the left vertebral artery, and using a 0.014-inch microguidewire (Synchro2, Boston Scientific), an aspiration catheter (ACE 68; Penumbra) was advanced to the middle third of the basilar artery and manual aspiration with a 50-mL syringe was attempted but without success. Due to local vasospasm of the left V4 segment, the coaxial system was retracted and then placed in the proximal segment of the right vertebral artery. The selective injection revealed an irregular stenosis of the V3 segment, most probably due to dissection – and most likely the source of the embolic distal occlusion. After successful navigation of the stenotic segment with the Velocity microcatheter (Penumbra), the aspiration catheter was carefully advanced distal to the dissected segment. The microcatheter was then navigated to the left PCA, and a pREset 4 × 20 mm stent retriever (Phenox) was deployed and was then retracted under aspiration, but the vessel remained occluded. A second thrombectomy manoeuvre carried out through the right PCA using the same thrombectomy device was also unsuccessful. With the third thrombectomy, using a pREset 6 × 30 mm stent retriever (Phenox), the thrombus was successfully removed, and injection of the left vertebral artery revealed a complete recanalisation of the vertebral artery (Fig. 5b). The radiation exposure for the interventional procedure was 20,972 mGy · m². The duration of the procedure was 2 h 30 min, and the total time to recanalisation from symptom onset was 5 h 52 min.

In order to determine the prognosis and the necessity of an emergent caesarean section, a follow-up MRI was performed 5 h later, which showed some scattered, small ischaemic lesions in both cerebellar hemispheres (Fig. 6a) and a small lesion in the tegmentum mesencephali. The pons and medulla were unremarkable (Fig. 6b). The patient was then maintained on weight-adapted infusion of eptifibatide for the following day and then switched to a dual antiplatelet regimen, initially with aspirin and ticagrelor, then with aspirin and prasugrel due to inadequate inhibition at the P2Y₁₂ receptors in point-of-care platelet function tests (Multiplate, Roche; VerifyNow, Accumetrics). The patient was weaned successfully on the first post-interventional day, and apart from mild internuclear ophthalmoplegia there were no residual neurological symptoms (mRS score 1). In order to maintain dual platelet function inhibition, 300 mg aspirin and 30 mg prasugrel daily were required. The higher-than-normal dose of prasugrel was required because lower doses had shown insufficient antiplatelet activity in point-of-care testing (VerifyNow and Multiplate devices).

The pregnancy is ongoing, so far with no apparent impact from the basilar artery occlusion and the endovascular treatment. An ultrasound examination of the baby showed no evidence of fetal or intrauterine complications.

Fig. 5. **a** Angiography via the left vertebral artery demonstrated a mid-basilar occlusion. **b** After successful mechanical thrombectomy there was complete restoration of flow. **c** After retracting the coaxial system into the proximal segment of the right vertebral artery, an extracranial pseudoaneurysm was noted at the site of the dissection. **d** Due to the stenosis and the high risk of early thrombus formation at the site of the wall injury, the decision was made to cover the dissection with a flow diverter stent. A weight-adapted bolus of eptifibatide was given, followed by careful placement of a compatible Marksman 0.027-inch microcatheter (Medtronic) distal to the dissected segment; a 3.5 × 16 mm Pipeline Flex Shield flow diverter stent (Medtronic) was successfully deployed with full coverage of the dissection and almost complete cessation of blood flow into the pseudoaneurysm.

Fig. 6. Several small foci of infarction are seen in the cerebellar hemispheres (**a**), but the pons and medulla have a normal appearance (**b**).

Discussion

Ischaemic stroke in pregnancy is a rare occurrence; however, it can have disastrous consequences not only for the mother but also for the child and the family unit depending on its severity. The incidence of stroke in pregnancy varies, and according to 3 population-based studies, it ranges from 4 to 11 per 100,000 deliveries [1–3]. The risk of stroke appears to vary

during the different stages of pregnancy, with a relative risk of cerebral infarction of 0.7 during pregnancy which rises to 5.4 in the 6 weeks following delivery (of either a live or still birth) [3]. In-hospital series have observed a higher infarction frequency in the 3rd trimester, with a peak in the 1st postpartum week [1, 4, 5]. The exact cause of these inter-pregnancy variations is unknown.

Stroke in pregnancy is associated with medical conditions such as diabetes mellitus, hypertension, heart disease, sickle cell anaemia, thrombocytopenia, and thrombophilia. Lifestyle factors such as smoking and alcohol consumption are also linked to increases in pregnancy-related stroke [6]. Additionally, migraine-type headaches during pregnancy are strongly associated with an increased risk of stroke in pregnancy, with an odds ratio of 30.4 for ischaemic stroke. The underlying cause of ischaemic stroke in pregnancy can also be complicated by specific conditions such as pre-eclampsia and eclampsia, which can lead to ischaemic, but not necessarily thromboembolic, stroke.

Imaging in pregnant patients poses yet another potential diagnostic dilemma. In stroke patients, CT, CT angiography, and CT perfusion can provide a rapid answer to the presence of a proximal large vessel occlusion and information about the ischaemic penumbra. The availability of CT is also of practical benefit. However, radiation exposure during pregnancy should be minimised. Whilst the harmful effects of irradiation depend upon the gestational stage at which the exposure occurs, upon the total dose of radiation absorbed, and upon the rate at which it is absorbed, fetal exposure to radiation from CT examination of the head is extremely low [7]. However, whilst the radiation dose from an unenhanced head CT scan may be relatively low, the radiation dose from a perfusion CT scan can be considerably higher [8, 9] – and so will the scattered radiation to the fetus. With regard to MRI, the requirement to use gadolinium contrast medium may also pose a risk to the fetus, and therefore its use should be minimised [10–12] and non-contrast enhanced time-of-flight MR angiography could be an alternative imaging option. For these reasons, MRI is the preferable imaging option, and although there is some theoretical risk from the magnetic field and heating, there is no evidence of adverse effects.

The management of thromboembolic occlusion is also a matter of debate, as there are no randomised controlled trial data to guide management. The recombinant tissue plasminogen activator (rtPA) molecule is too large to cross the placental barrier, and thus cannot enter fetal circulation. Several case reports have recently been published that document the use of rtPA in stroke, the majority of which were in the 1st trimester. In the 11 published reports using either rtPA or urokinase, haemorrhagic complications were seen in 6 patients, with good outcomes for the fetus in 7 cases [13–18]. Conversely, in 1 case there was a spontaneous abortion (1st trimester), and there were 2 medical terminations (both 1st trimester), one of which was secondary to an intrauterine haematoma that developed after thrombolytic treatment. A study that reviewed the risk of haemorrhage with the use of thrombolytics during pregnancy found an overall maternal haemorrhage complication rate of 8% with a maternal mortality rate of 1.2% [19]. Similarly, in another study of 28 patients that received rtPA for various conditions, maternal mortality was 7% and fetal mortality 23% [13]. Therefore, with the limited information available it appears that the risk of thrombolysis is non-negligible, and whilst saving the life of the mother is paramount, this distinction can become increasingly challenging in the later stages of pregnancy, when patients are more likely to have thromboembolic infarctions.

To date only 2 cases of mechanical thrombectomy for thromboembolic stroke have been published [20]. Aaron et al. [20] recently published 2 cases of women, both of whom were in their 20s and in the 3rd trimester. One patient had undergone a previous mitral valve replacement, and her normal oral anticoagulants had been switched to low-molecular-weight heparin. One week later she developed acute left hemiplegia and an NIHSS score of 20. Urgent

MRI confirmed an evolving infarction and an M1 occlusion, which was successfully treated using aspiration thrombectomy. The patient had an NIHSS score of 1 at discharge and a successful delivery. In the second case presented, a similar switch to low-molecular-weight heparin was required for a mitral valve replacement with subsequent development of left hemiplegia and an NIHSS score of 21. Urgent MRI showed an evolving infarction, and the patient was successfully treated with aspiration thrombectomy, with an NIHSS score of 4 at discharge and a successful delivery 10 days later. These cases along with our own show that mechanical thrombectomy can be performed safely in pregnant patients. Our cases were very similar in that both of them presented with severe strokes and high NIHSS scores and both of them experienced an excellent recovery with mRS scores of ≤ 2 and no consequences to the babies.

The risks to the fetus, especially in the 3rd trimester, from scattered radiation during the procedure can be minimised by limiting the number of angiographic exposures performed intraoperatively as well as using low-dose fluoroscopy, pulsed fluoroscopy, tight collimation, and radiation shields. We used all of these tactics in our cases, and we also minimised the air gap between the flat panel detector and the patient in order to further minimise scatter. A further option can also be to use magnification sparingly, since magnification increases the radiation dose. This tactic was also employed in our cases to minimise radiation exposure; however, this must be balanced with the need for clear imaging results. Furthermore, given the relatively low complication rates of the procedure [21], mechanical thrombectomy should be considered an attractive treatment option despite the lack of randomised controlled trial data for this particular patient group.

Conclusion

Mechanical thrombectomy should be considered a viable and effective treatment option for patients presenting with thromboembolic infarction during pregnancy. The risks to the fetus can be minimised through imaging optimisation and careful planning prior to performing the thrombectomy. Given the risks associated with rtPA in this cohort, mechanical thrombectomy should be considered as the first treatment option.

Statement of Ethics

As this was a retrospective study, IRB approval was not required. Informed consent was provided by the patients.

Disclosure Statement

M.A. and P.B. serve as proctors and consultants for Phenox GmbH, with moderate financial compensation. H.H. is co-founder and shareholder of Phenox GmbH. The other authors have no potential conflict of interest.

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

References

- 1 Sharshar T, Lamy C, Mas JL: Incidence and causes of strokes associated with pregnancy and puerperium. A study in public hospitals of Ile de France. Stroke in Pregnancy Study Group. Stroke 1995;26:930–936.
- 2 Wiebers DO, Whisnant JP: The incidence of stroke among pregnant women in Rochester, Minn, 1955 through 1979. JAMA 1985;254:3055–3057.
- 3 Kittner SJ, Stern BJ, Feaser BR, et al: Pregnancy and the risk of stroke. N Engl J Med 1996;335:768–774.
- 4 Jaigobin C, Silver FL: Stroke and pregnancy. Stroke 2000;31:2948–2951.
- 5 Skidmore FM, Williams LS, Fradkin KD, et al: Presentation, etiology, and outcome of stroke in pregnancy and puerperium. J Stroke Cerebrovasc Dis 2001;10:1–10.
- 6 James AH, Bushnell CD, Jamison MG, et al: Incidence and risk factors for stroke in pregnancy and the puerperium. Obstet Gynecol 2005;106:509–516.
- 7 Hall EJ, Giaccia AJ: Radiobiology for the Radiologist. Philadelphia, Lippincott Williams & Wilkins, 2006.
- 8 Hoang JK, Wang C, Frush DP, et al: Estimation of radiation exposure for brain perfusion CT: standard protocol compared with deviations in protocol. AJR Am J Roentgenol 2013;201:W730–W734.
- 9 Ringelstein A, Lechel U, Fahrendorf DM, et al: Radiation exposure in perfusion CT of the brain. J Comput Assist Tomogr 2014;38:25–28.
- 10 Webb JAW, Thomsen HS, Morcos SK, et al: The use of iodinated and gadolinium contrast media during pregnancy and lactation. Eur Radiol 2005;15:1234–1240.
- 11 Kanal E, Borgstede JP, Barkovich AJ, et al: American College of Radiology White Paper on MR Safety: 2004 update and revisions. AJR Am J Roentgenol 2004;182:1111–1114.
- 12 Kanal E, Borgstede JP, Barkovich AJ, et al: American College of Radiology White Paper on MR Safety. AJR Am J Roentgenol 2002;178:1335–1347.
- 13 Leonhardt G, Gaul C, Nietsch HH, et al: Thrombolytic therapy in pregnancy. J Thromb Thrombolysis 2006;21:271–276.
- 14 Dapprich M, Boessenecker W: Fibrinolysis with alteplase in a pregnant woman with stroke. Cerebrovasc Dis 2002;13:290.
- 15 Elford K, Leader A, Wee R, et al: Stroke in ovarian hyperstimulation syndrome in early pregnancy treated with intra-arterial rt-PA. Neurology 2002;59:1270–1272.
- 16 Johnson DM, Kramer DC, Cohen E, et al: Thrombolytic therapy for acute stroke in late pregnancy with intra-arterial recombinant tissue plasminogen activator. Stroke 2005;36:e53–e55.
- 17 Wiese KM, Talkad A, Mathews M, et al: Intravenous recombinant tissue plasminogen activator in a pregnant woman with cardioembolic stroke. Stroke 2006;37:2168–2169.
- 18 Murugappan A, Coplin WM, Al-Sadat AN, et al: Thrombolytic therapy of acute ischemic stroke during pregnancy. Neurology 2006;66:768–770.
- 19 Turrentine MA, Braems G, Ramirez MM: Use of thrombolytics for the treatment of thromboembolic disease during pregnancy. Obstet Gynecol Surv 1995;50:534–541.
- 20 Aaron S, Shyamkumar NK, Alexander S, et al: Mechanical thrombectomy for acute ischemic stroke in pregnancy using the penumbra system. Ann Indian Acad Neurol 2016;19:261–263.
- 21 Palaniswami M, Yan B: Mechanical thrombectomy is now the gold standard for acute ischemic stroke: implications for routine clinical practice. Interv Neurol 2015;4:18–29.